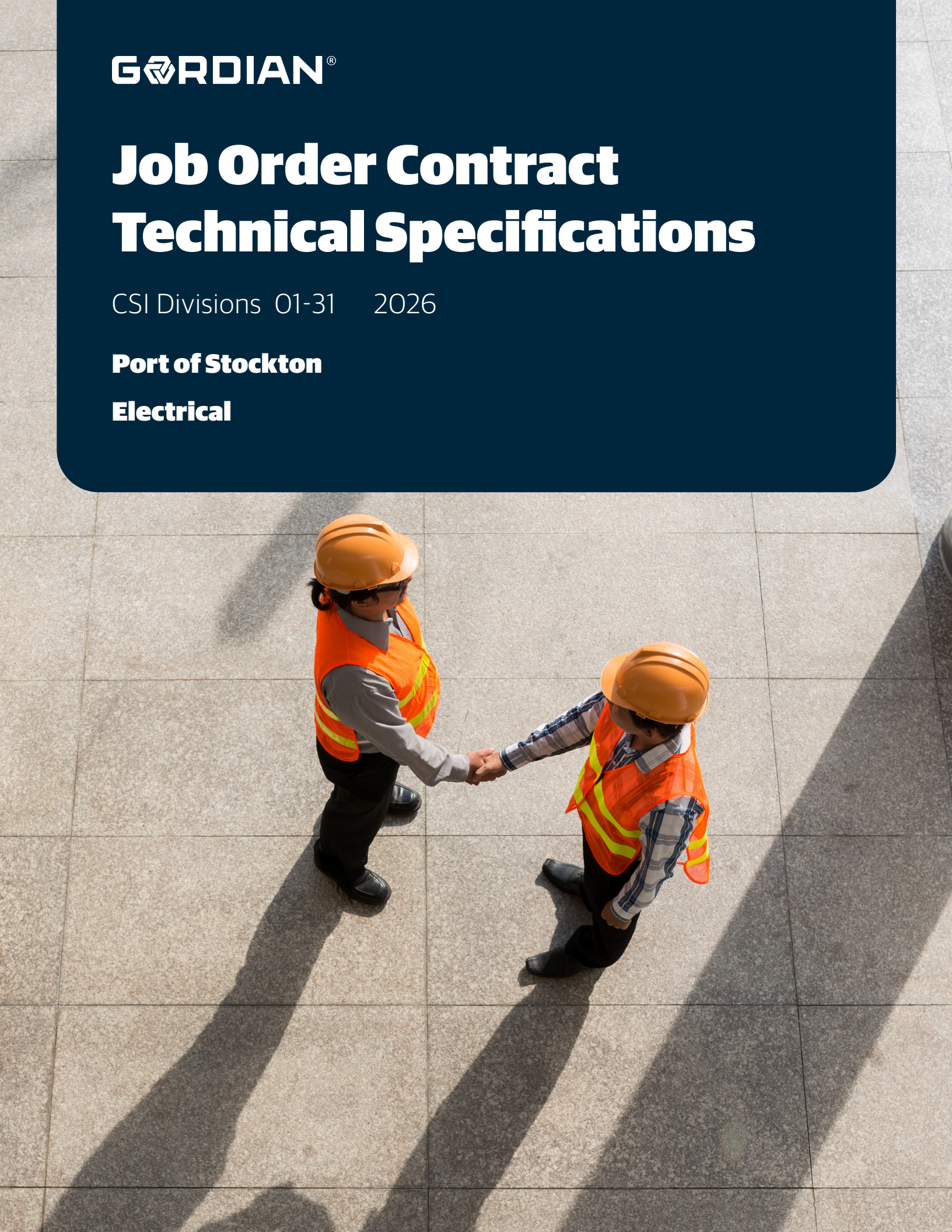
GORDIAN®

Job Order Contract Technical Specifications

CSI Divisions 01-31 2026

Port of Stockton

Electrical



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01 General Requirements

01 00 00 00 General Requirements
01 11 13 00 Work Covered by Contract Documents
01 22 00 00 No Specification Required
01 40 00 00 Quality Requirements
01 42 00 00 References
01 50 00 00 Temporary Facilities and Controls
01 51 13 00 Temporary Electricity
01 54 23 00 Temporary Scaffolding and Platforms
01 54 23 00a Unit Masonry
01 55 26 00 Parking Control Equipment
01 55 26 00a Fabricated Control Booths
01 56 26 00 Site Clearing
01 56 39 00 Temporary Tree and Plant Protection
01 57 23 00 Temporary Storm Water Pollution Control
01 58 13 00 Dimensional Letter Signage
01 58 13 00a Panel Signage
01 60 00 00 Product Requirements
01 74 19 00 Construction Waste Management and Disposal
01 91 13 00 Commissioning Of Fire Suppression

02 Existing Conditions

02 41 19 00 Selective Demolition
02 41 19 13 Cutting and Patching
02 61 00 00 Removal and Disposal of Contaminated Soils
02 82 16 00 Engineering Control of Asbestos Containing Materials
02 82 33 00 Removal Of Friable Asbestos-Containing Materials
02 82 33 00a Removal Of Nonfriable Asbestos-Containing Materials
02 83 00 00 Lead Remediation
02 83 19 00 Lead-Based Paint Remediation
02 83 19 00a XRF Testing For Lead-Based Paint
02 83 19 00b Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 84 16 00 Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
02 87 13 00 Mold Remediation
02 87 16 13 Bird Excrement Removal

05 Metals

05 01 70 51 Decorative Metal Cleaning
05 01 70 61 Decorative Metal Repair
05 01 70 63 Decorative Metal Refinishing
05 05 19 00 Metal Fabrications
05 12 00 00 Structural Steel Framing
05 21 00 00 Steel Joist Framing
05 31 13 00 Steel Decking
05 40 00 00 Cold-Formed Metal Framing
05 70 00 00 Decorative Metal
05 71 00 00 Decorative Metal Stairs
05 71 13 00 Fabricated Metal Spiral Stairs
05 73 00 00 Decorative Metal Railings
05 73 00 00a Glazed Decorative Metal Railings
05 75 00 00 Decorative Formed Metal

06 Wood, Plastics, and Composites

06 10 00 00 Rough Carpentry
06 13 00 00 Heavy Timber Construction
06 15 00 00 Wood Roof Decking

06 15 00 00a Wood Patio Decking
06 16 00 00 Sheathing

07 Thermal And Moisture Protection

07 62 00 00 Sheet Metal Flashing And Trim
07 63 00 00 Common Work Results for Fire Suppression
07 63 00 00a Common Work Results for Plumbing
07 63 00 00b Common Work Results for HVAC
07 65 16 00 Built-Up Asphalt Roofing
07 65 16 00a Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
07 65 16 00b Coated Foamed Roofing
07 91 00 00 Preformed Joint Seals
07 92 00 00 Joint Sealants
07 92 19 00 Acoustical Joint Sealants
07 95 13 00 Parking Deck Expansion Joint Cover Assemblies
07 95 13 13 Interior Expansion Joint Cover Assemblies
07 95 13 16 Exterior Expansion Joint Cover Assemblies

09 Finishes

09 01 20 00 Gypsum Board Renovation
09 01 20 91 Plaster Restoration
09 01 30 91 Ceramic Tiling
09 01 60 91 Polished Concrete Finishing
09 01 60 91a Portland Cement Terrazzo Flooring
09 01 60 91b Tile Carpeting
09 01 60 91c Sheet Carpeting
09 01 90 52 Maintenance of Cast-in-Place Concrete
09 01 90 52a Maintenance Repainting
09 05 61 13 Moisture Vapor Emission Control
09 22 16 00 Non-Structural Metal Framing
09 23 00 00 Gypsum Plastering
09 24 00 00 Cement Plastering
09 29 00 00 Gypsum Board
09 51 13 00 Acoustical Panel Ceilings
09 51 23 00 Acoustical Tile Ceilings
09 51 33 00 Acoustical Metal Pan Ceilings
09 54 00 00 Stretched-Fabric Ceiling Systems
09 54 00 00a Fabric-Wrapped Ceiling Panels
09 54 23 00 Linear Metal Ceilings
09 91 13 00 Exterior Painting
09 91 23 00 Interior Painting
09 93 00 00 Staining and Transparent Finishing
09 96 00 00 High-Performance Coatings
09 96 53 00 Elastomeric Coatings
09 97 26 00 Cementitious Coatings
09 97 63 00 Coatings for HVAC

13 Special Construction

13 46 13 00 Lightning Protection for Structures

26 Electrical

26 01 00 00 Supplemental Requirements for Electrical
26 05 00 00 Sleeves and Sleeve Seals for Electrical Raceways and Cabling

26 05 13 00 Medium-Voltage Cables
26 05 19 00 Low-Voltage Electrical Power Conductors and Cables
26 05 23 00 Control-Voltage Electrical Power Cables
26 05 26 00 Grounding and Bonding for Electrical Systems
26 05 29 00 Hangers And Supports For Electrical Systems
26 05 33 13 Conduits for Electrical Systems
26 05 33 16 Boxes and Covers for Electrical Systems
26 05 33 23 Surface Raceways for Electrical Systems
26 05 36 00 Cable Trays for Electrical Systems
26 05 39 00 Underfloor Raceways For Electrical Systems
26 05 43 00 Underground Ducts and Utility Structures
26 05 43 00a Overhead Medium-Voltage Wiring
26 05 46 00 Poles for Electrical Systems
26 05 53 00 Identification for Electrical Systems
26 08 00 00 Commissioning Of Electrical Systems
26 09 00 00 Addressable Luminaire Lighting Controls
26 09 00 00a Relay-Based Lighting Controls
26 09 23 00 Electrical Power Monitoring
26 09 23 00a Lighting Control Devices
26 11 16 00 Secondary Unit Substations with Switchboard Secondary
26 11 16 00a Secondary Unit Substations with Motor Control Center Secondary
26 11 16 11 Secondary Unit Substations with Switchgear Secondary
26 12 13 00 Liquid-Filled, Medium-Voltage Transformers
26 12 16 00 Dry-Type, Medium-Voltage Transformers
26 12 19 00 Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
26 12 19 00a Low-Voltage Switchgear
26 13 29 00 Medium-Voltage Compartmentalized Switchgear
26 21 16 00 Paralleling Low-Voltage Switchgear
26 22 13 00 Low-Voltage Distribution Transformers
26 24 13 00 Switchboards
26 24 16 00 Panelboards
26 24 16 00a Electronically Operated Circuit-Breaker Panelboards
26 24 19 00 Motor-Control Centers
26 25 00 00 Low-Voltage Enclosed Bus Assemblies
26 27 13 00 Electricity Metering
26 27 16 00 Electrical Cabinets and Enclosures
26 27 19 00 Multi-Outlet Assemblies
26 27 26 00 Wiring Devices
26 27 26 00a Receptacles with Arc-Fault and Ground-Fault Protective Devices
26 27 26 00b Connectors, Cords, and Plugs
26 27 33 00 Power Distribution Units
26 28 13 00 Fuses
26 28 16 00 Enclosed Switches And Circuit Breakers
26 29 13 00 Manual and Magnetic Motor Controllers
26 29 13 00a Soft-Start Motor Controllers
26 29 23 00 Variable-Frequency Motor Controllers
26 29 33 13 Diesel-Drive, Centrifugal Fire Pumps
26 29 33 13a Pressure-Maintenance Pumps
26 31 00 00 Photovoltaic Collectors
26 32 13 13 Diesel-Engine-Driven Generator Sets
26 32 13 19 Bi-Fuel-Engine-Driven Generator Sets
26 33 43 00 Battery Chargers
26 33 43 00a Public Address Systems
26 33 53 00 Static Uninterruptible Power Supply
26 35 33 00 Power Factor Correction Equipment
26 36 00 00 Transfer Switches
26 43 13 00 Surge Protective Devices for Low-Voltage Electrical Power Circuits
26 50 00 00 Lighting
26 55 61 00 Theatrical Lighting
26 55 68 00 Athletic Field Lighting

27 Communications

27 11 00 00 Communications Equipment Room Fittings
27 13 13 00 Communications Copper Backbone Cabling
27 13 23 00 Communications Optical Fiber Backbone Cabling
27 15 13 00 Communications Copper Horizontal Cabling
27 15 23 00 Communications Optical Fiber Horizontal Cabling

27 15 33 00 Communications Coaxial Horizontal Cabling
27 41 23 00 Educational Intercommunications and Program Systems
27 41 33 00 Master Antenna Television System
27 51 23 20 Commercial Intercommunications and Program Systems
27 52 23 00 Nurse Call Code Blue Systems
27 53 13 00 Clock Systems

28 Electronic Safety and Security

28 10 00 00 Access Control
28 10 00 00a Access Control Software and Database Management
28 10 00 00b Access Control System Hardware
28 15 00 00 Integrated Access Control Hardware Devices
28 15 00 00a Access Control Credentials
28 15 00 00b Electrified Locking Devices and Accessories
28 15 00 00c Egress Management Devices
28 15 00 00d Telephone Entry Systems
28 15 00 00e Intercom Entry Systems
28 15 00 00f Electronic Key Management Systems
28 15 00 00g Access Control Electronic Turnstiles and Mobility Systems
28 15 11 00 Integrated Credential Readers and Entry Management
28 16 11 00 Intrusion Detection
28 16 11 00a Area and Perimeter Intrusion Detection
28 20 00 00 Video Surveillance
28 40 00 00 Emergency Responder Communications Enhancement System ERCES
28 46 00 00 Fire Detection and Alarm
28 47 00 00 Mass Notification

31 Earthwork

31 05 13 00 Subdrainage
31 20 00 00 Earth Moving
31 23 16 13 Excavation Support and Protection
31 23 16 16 Chain Link Fences And Gates
31 23 19 00 Dewatering
31 25 14 23 Unit Paving

SECTION 01 00 00 00 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 BRACKETED OPTIONS

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

1.2 WARRANTY

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 00 00 00

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

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SECTION 01 11 13 00 - WORK COVERED BY CONTRACT DOCUMENTS

1.1 GENERAL

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

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

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

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01 11 13 00

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Task	Specification	Specification Description
01 11 13 00	01 00 00 00	General Requirements
01 20 00 00	01 00 00 00	General Requirements

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SECTION 01 22 00 00 - NO SPECIFICATION REQUIRED

1.1 GENERAL

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

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01 22 00 00

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

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SECTION 01 40 00 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

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

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

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

C. Related Requirements:

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

1.2 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.3 DELEGATED DESIGN SERVICES

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

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

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

1.4 CONFLICTING REQUIREMENTS

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

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

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

1.5 ACTION SUBMITTALS

A. Mockup Shop Drawings:

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

1.6 INFORMATIONAL SUBMITTALS

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

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

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

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

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

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

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

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

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

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

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

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

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

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

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

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

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

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

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

1.8 REPORTS AND DOCUMENTS

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

1. Date of issue.

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

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

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

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

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

1.9 QUALITY ASSURANCE

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

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

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

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

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

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

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

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

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

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

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

1. Contractor's Responsibilities:

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

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

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

1. Build mockups of size indicated.

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

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

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

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

1.10 QUALITY CONTROL

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.11 SPECIAL TESTS AND INSPECTIONS

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

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

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

3.1 TEST AND INSPECTION LOG

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

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

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

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

3.2 REPAIR AND PROTECTION

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

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

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

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

END OF SECTION 01 40 00 00

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

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SECTION 01 42 00 00 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

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

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

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

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

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

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

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

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

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

1.2 INDUSTRY STANDARDS

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

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

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

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

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

1.3 ABBREVIATIONS AND ACRONYMS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

END OF SECTION 01 42 00 00

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Task	Specification	Specification Description
01 42 00 00	01 00 00 00	General Requirements
01 42 00 00	01 40 00 00	Quality Requirements
01 42 13 00	01 00 00 00	General Requirements
01 42 13 00	01 40 00 00	Quality Requirements
01 42 13 00	01 42 00 00	References
01 42 16 00	01 00 00 00	General Requirements
01 42 16 00	01 40 00 00	Quality Requirements
01 42 16 00	01 42 00 00	References
01 42 19 00	01 00 00 00	General Requirements
01 42 19 00	01 40 00 00	Quality Requirements
01 42 19 00	01 42 00 00	References
01 42 21 00	01 00 00 00	General Requirements
01 42 21 00	01 40 00 00	Quality Requirements
01 42 21 00	01 42 00 00	References
01 45 00 00	01 00 00 00	General Requirements
01 45 00 00	01 40 00 00	Quality Requirements
01 45 23 00	01 00 00 00	General Requirements
01 45 23 00	01 22 00 00	No Specification Required
01 45 23 00	01 40 00 00	Quality Requirements
01 45 29 00	01 00 00 00	General Requirements
01 45 29 00	01 22 00 00	No Specification Required
01 45 29 00	01 40 00 00	Quality Requirements

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SECTION 01 50 00 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

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

B. Related Requirements:

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

1.2 USE CHARGES

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

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

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

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

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

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

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

1.3 INFORMATIONAL SUBMITTALS

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

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

directed by the Owner.

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

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

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

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

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

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

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

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

1.4 QUALITY ASSURANCE

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

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

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

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

1.5 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

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

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

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

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

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

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

2.2 TEMPORARY FACILITIES

A. Field Offices:

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

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

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

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

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

1. Store combustible materials apart from building.

2.3 EQUIPMENT

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

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

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

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

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

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

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

3.2 INSTALLATION, GENERAL

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

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

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

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

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

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

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

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

3.3 TEMPORARY UTILITY INSTALLATION

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

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

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

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

C. Water Service:

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

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

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

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

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

F. Electric Power Service:

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

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

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

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

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

1. Provide additional telephone lines for the following:

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

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

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

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

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

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

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

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

3.4 SUPPORT FACILITIES INSTALLATION

A. Comply with the following:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

I. Waste Disposal Facilities:

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

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

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

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

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

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

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

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

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

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

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

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

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

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

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

C. Temporary Erosion and Sedimentation Control:

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

E. Tree and Plant Protection:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.6 MOISTURE AND MOLD CONTROL

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

and Mold Protection Plan.

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

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

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

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

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

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

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

3.7 OPERATION, TERMINATION, AND REMOVAL

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

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

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

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

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

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

END OF SECTION 01 50 00 00

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

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SECTION 01 51 13 00 - TEMPORARY ELECTRICITY

1.1 DESCRIPTION OF WORK

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

1.2 GENERAL

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

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

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

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

1.3 PRODUCTS

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

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

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

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

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

2) Provide necessary fittings in accordance with NEC.

1.4 EXECUTION

A. Examination

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

B. Preparation

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

C. Laying Out Work

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

D. Location Of Equipment And Piping

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

E. Electrical Work

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

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

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

3. Garbage Disposal Electrical Hook-up: See Section “Plumbing.” Comply with NFPA 70 (NEC):
a. Wiring: Install from disposal through concealed spaces to house panel, anchoring wire, and providing necessary fittings.
b. Switch: Install above counter top backsplash.
4. Range Hood Electrical Hook-up: See Section “Residential Appliances.” Comply with NFPA 70 (NEC):
a. Electric service: Install insulated wire from range hood through concealed spaces to house panel, anchoring wire, and providing necessary fittings.
5. Water Heater Electrical Hook-up: See Division 15 Section “Domestic Water Heaters.” Comply with NFPA 70 (NEC).
6. Furnace Electrical Hook-up: See Section “Furnaces.” Comply with NFPA 70 (NEC).
7. Smoke Detector Electrical Hook-up: See “Fire Alarm.” Comply with NFPA 70 (NEC).

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

END OF SECTION 01 51 13 00

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Task	Specification	Specification Description
01 51 13 00	01 00 00 00	General Requirements
01 51 13 00	26 24 16 00	Panelboards
01 51 26 00	01 00 00 00	General Requirements
01 52 00 00	01 00 00 00	General Requirements
01 52 13 00	01 00 00 00	General Requirements
01 52 13 00	01 22 00 00	No Specification Required
01 52 13 00	01 50 00 00	Temporary Facilities and Controls
01 52 19 00	01 00 00 00	General Requirements
01 52 19 00	01 50 00 00	Temporary Facilities and Controls
01 53 00 00	01 00 00 00	General Requirements
01 53 16 00	01 00 00 00	General Requirements
01 53 16 00	01 22 00 00	No Specification Required
01 53 23 00	01 00 00 00	General Requirements
01 54 00 00	01 00 00 00	General Requirements

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SECTION 01 54 23 00 - TEMPORARY SCAFFOLDING AND PLATFORMS

1.1 GENERAL

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

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

1.2 PRODUCTS

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

1.3 EXECUTION - (Section not used.)

END OF SECTION 01 54 23 00

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SECTION 01 54 23 00A - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Clay masonry units.
3. Structural clay facing tile.
4. Fireplace and chimney lining units.
5. Lintels
6. Mortar and grout materials
7. Reinforcement.
8. Ties and anchors.
9. Embedded flashing.
10. Accessories.
11. Mortar and grout mixes.

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

1. Cast-stone trim in unit masonry.
2. Stone trim units in unit masonry.
3. Steel lintels in unit masonry.
4. Steel shelf angles for supporting unit masonry.
5. Cavity wall insulation adhered to masonry backup.

C. Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 019119.43 "Exterior Enclosure Commissioning."
3. Section 033000 "Cast-in-Place Concrete" for [**installing**] dovetail or channel slots for masonry-veneer anchors.
4. Section 042300 "Glass Unit Masonry" for glass block.
5. Section 042613 "Masonry Veneer" for unit masonry set as veneer.
6. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
7. Section 044313.13 "Anchored Stone Masonry Veneer" for thin stone trim set as anchored veneer.
8. Section 044313.16 "Adhered Stone Masonry Veneer" for thin stone trim set as adhered veneer.
9. Section 047200 "Cast Stone Masonry" for cast stone trim units.
10. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
11. Section 071900 "Water Repellents" for water repellents topically applied to unit masonry assemblies.
12. Section 072100 "Thermal Insulation" for cavity wall insulation.
13. Section 076200 "Sheet Metal Flashing and Trim" for [**exposed**] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
14. Section 089516 "Wall Vents" for wall vents (brick vents).
15. Section 096313 "Brick Flooring" for interior brick flooring.
16. Section 096313.35 "Chemical-Resistant Brick Flooring" for chemical-resistant, interior brick flooring.
17. Section 097519 "Stone Trim" for interior stone window stools.
18. Section 321400 "Unit Paving" for exterior unit masonry paving.

19. Section 323223 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Exposed: Weather-exposed side of a constructed wall.

C. Reinforced Masonry: Masonry containing reinforcing steel within grouted cells.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI PRC 315R. [**Indicate elevations of reinforced walls.**]
3. Lintel design and types required.
4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Acoustical CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Rigid, Cellular Thermal Insulation CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Low carbon CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
8. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
9. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
10. Glazed Structural Clay Facing Tile: [**Small-scale units**][**Full-size units, minimum of five**] .
11. Colored Mortar: Full range of manufacturer's standard colors.
12. Aggregate for Mortar: Range of aggregate colors for colored-aggregate mortar.
13. Weep/cavity vents.

D. Samples for Verification: For each type and color of the following:

1. Architectural CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
2. Prefaced CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
3. Acoustical CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
4. Rigid, Cellular Thermal Insulation CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
5. Low carbon CMUs: [**Small-scale units**][**Full-size units, minimum of five**] .
6. Concrete Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
7. Hollow Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .

8. Solid Clay Facing Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
9. Glazed Brick: [**Small-scale units**][**Full-size units, minimum of five**] .
10. Glazed Structural Clay Facing Tile: [**Small-scale units**][**Full-size units, minimum of five**] .
11. Colored mortar.
12. Weep/cavity vents.
13. Special Masonry Shapes: One of each unique shape.
14. Pigmented Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
15. Colored-Aggregate Mortar: Make Samples using same sand and mortar ingredients to be used on Project.
16. Cavity drainage material.
17. Accessories embedded in masonry.

E. Delegated Design Submittals: For [**masonry anchors and ties**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

1.5 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only.

B. Material Certificates: For each type of the following:

1. Masonry units.

a. Include [**data on material properties**][**material test reports substantiating compliance with requirements**] .
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M [**or a list of addresses of buildings in Project's area where proposed brick has been used**

successfully and with a history of durability] .

e. For masonry units [**used in structural masonry**] , include data and calculations establishing average net-area compressive strength of units.

2. Integral water repellent used within CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar [**and grout**] . Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

D. Qualification Statements: For testing agency.

E. Delegated Design Engineer Qualifications: For [**masonry anchors and ties**].

F. Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements for [**cold**][**and**][**hot**] weather.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 MOCKUPS

A. Sample Panel Mockups: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**] high [**by full thickness**] .
2. Build sample panels facing south.
3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of panels with masonry cleaner indicated.

5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities, as directed by the Owner.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels, as directed by the Owner.

B. Wall Mockups: Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**and**][**to set quality standards for installation**] . [**See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups.**]

1. Build mockup [**as indicated on Drawings**] .
2. Build mockups for [**each type of exposed unit masonry construction**][**typical exterior wall**][**typical interior wall**][**typical exterior and interior walls**] in sizes approximately [**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**][**96 inches (2438 mm)**] long by [**36 inches (914 mm)**][**48 inches (1219 mm)**][**60 inches (1524 mm)**][**72 inches (1829 mm)**] high by full thickness, including face and backup wythes and accessories.

    a. Include a sealant-filled joint at least **16 inches (406 mm)** long in [**each**][**exterior wall**] mockup.
    b. Include lower corner of window opening [**framed with stone trim**] at upper corner of exterior wall mockup. Make opening approximately **12 inches (305 mm)** wide by **16 inches (406 mm)** high.
    c. Include through-wall flashing installed for a **24-inch (610-mm)** length in corner of exterior wall mockup approximately **16 inches (406 mm)** down from top of mockup, with a **12-inch (305-mm)** length of flashing left exposed to view (omit masonry above half of flashing).
    d. Include wall substrate and cavity materials, veneer anchors, flashing [**cavity drainage material**], and weep holes in exterior masonry-veneer wall mockup.
    e. Include specified unit masonry on one face of interior unit masonry wall mockup.

3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
4. Clean [**one-half of**] exposed faces of mockups with masonry cleaner as indicated.
5. Protect accepted mockups from the elements with weather-resistant membrane.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
7. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of **24 inches (610 mm)** down both sides of walls, and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of **24 inches (610 mm)** down face next to unconstructed wythe, and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**exposed masonry units**][**cementitious mortar components**][**and**][**mortar aggregate**] from single [**source**][**producer**][**or**][**manufacturer**] .

B. For [**exposed masonry units**][**and**][**cementitious mortar components**] , obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Masonry to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] .

B. Provide [**structural**] unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 402/602.
2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 402/602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work [**and will be within 20 ft. (6 m) vertically and horizontally of a walking surface**] .

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

A. Regional Materials: Verify CMUs are manufactured within **100 miles (160 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify CMUs are manufactured within **500 miles (800 km)** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide [**square-edged**][**bullnose**] units for outside corners unless otherwise indicated.

D. CMUs: ASTM C90, [**normal weight**][**medium weight**][**lightweight**][**unless otherwise indicated**] .

1. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
2. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
3. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

E. Architectural CMUs: ASTM C90, [**normal-weight**][**medium-weight**][**lightweight**] architectural units.

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

    a. [**Angelus Block Co., Inc.**]
    b. [**Echelon Masonry, an Oldcastle APG brand**]
    c. [**York Building Products**]

2. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
3. Pattern and Texture: [**Standard pattern, ground-face finish**][**Standard pattern, split-face finish**][**Standard pattern, split-ribbed finish**][**Scored vertically to appear square in stacked bond, standard finish**][**Triple scored vertically to appear as soldier courses in stacked bond, standard finish**] [**Match Architect's samples.**]
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.

F. Prefaced CMUs: ASTM C90, lightweight, with manufacturer's standard smooth resinous facing complying with ASTM C744.

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

    a. [**Echelon Masonry, an Oldcastle APG brand**]
    b. [**York Building Products**]

2. Composition: [**Hollow**][**Solid**] units.
3. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.6-mm-)** wide returns of facing to create **1/4-inch- (6.2-mm-)** wide mortar joints with modular coursing.
4. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

G. Acoustical CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] sound-absorbing units.

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

    a. [**Acme Brick Company**]
    b. [**Echelon Masonry, an Oldcastle APG brand**]
    c. [**RPG Acoustical Systems, Inc.**]
    d. [**Sound Seal**]

2. Surface Characteristics: [**Slotted**][**Textured**] .
3. Cavity Fill: [**Fibrous filler**][**Galvanized steel septum**][**Unfilled**] .

4. Sound Transmission Classification (STC): In accordance with ASTM E90 and ASTM E413.
5. Noise Reduction Coefficient (NRC): In accordance with ASTM C423 and ASTM E795.

H. Rigid, Cellular Thermal Insulation CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units containing rigid, specially shaped, molded-polystyrene insulation complying with ASTM C578, Type I, designed for installing in cores of CMUs.

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

    a. [**Concrete Block Insulating Systems**]
    b. [**Echelon Masonry, an Oldcastle APG brand**]
    c. [**Shelter Enterprises Inc.**]
    d. [**York Building Products**]

2. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.
3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

I. Low-Carbon CMUs: ASTM C90, [**lightweight**][**medium-weight**][**normal-weight**] units with low embodied carbon.

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

    a. [**CarbonBuilt**]
    b. [**CarbonCure**]
    c. [**CarbonKind**]
    d. [**CarbonX**]
    e. [**Pozzotive (Glenwood Mason Supply)**]

2. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with prefaced surfaces having **1/16-inch- (1.5-mm-)** wide returns of facing to create **1/4-inch- (6-mm-)** wide mortar joints with modular coursing.
3. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

J. Concrete Building Brick: ASTM C55, [**normal-weight**][**medium-weight**][**lightweight**] solid units.

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

    a. [**Acme Brick Company**]
    b. [**Belden Brick Company (The)**]
    c. [**Bilco Brick Company**]
    d. [**Echelon Masonry, an Oldcastle APG brand**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches**

(70 mm)][3-5/8 inches (92 mm)] high by 7-5/8 inches (194 mm) long.

K. Concrete Facing Brick: ASTM C1634, [**normal-weight**][**medium-weight**][**lightweight**] solid units.

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

a. [**Acme Brick Company**]
b. [**Belden Brick Company (The)**]
c. [**Bilco Brick Company**]
d. [**Echelon Masonry, an Oldcastle APG brand**]
e. [**Westbrook Concrete Block Co., Inc.**]

2. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by [2-1/4 inches (57 mm)][2-3/4 inches (70 mm)][3-5/8 inches (92 mm)] high by [7-5/8 inches (194 mm)][11-5/8 inches (295 mm)][15-5/8 inches (397 mm)] long.
3. Texture: [**Smooth-face**][**Split-face**][**Ground-face**] finish. [**Match Architect's samples**].
4. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**] .
5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample, as directed by the Owner.

L. Concrete Masonry Unit Admixtures:

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, will show no visible water or leaks on the back of test specimen.

a. Location: [**For exposed units**][**and**][**where indicated on Drawings**] .

2.5 CLAY MASONRY UNITS

A. Regional Materials: Verify brick is manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Regional Materials: Verify brick is manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications [**where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels**][**requiring brick of size, form, color, and texture on exposed surfaces that cannot be**

produced by sawing][**where shapes produced by sawing would result in sawed surfaces being exposed to view**] .

D. Hollow Clay Facing Brick: ASTM C652, Grade [**SW**][**MW**] , Type [**HBA**][**HBB**][**HBX**][**HBS**] , Class [**H40V**][**H60V**] .

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

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Echelon Masonry, an Oldcastle APG brand**]
   e. [**Endicott Clay Products Co**]
   f. [**General Shale, Inc.**]
   g. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**as directed by the Owner**] .

E. Solid Clay Facing Brick: ASTM C216, Grade [**SW**][**MW**] , Type [**FBX**][**FBS**][**FBA**] .

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

   a. [**Acme Brick Company**]
   b. [**Belden Brick Company (The)**]
   c. [**Bilco Brick Company**]
   d. [**Boral Bricks, Inc; Boral Limited**]
   e. [**Echelon Masonry, an Oldcastle APG brand**]
   f. [**Endicott Clay Products Co**]
   g. [**General Shale, Inc.**]
   h. [**Glen-Gery Corporation**]

2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)**[**or have a history of successful use in Project's area**] .
5. Size (Actual Dimensions): [**2-3/4 inches (70 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**] wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**2-5/8 inches (67 mm)**][**2-13/16 inches (71 mm)**][**3-1/2 inches (89 mm)**][**3-5/8 inches (92 mm)**][**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**] high by [**7-1/2 inches (190 mm)**][**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**9-5/8 inches (244 mm)**][**11-1/2 inches (292 mm)**][**11-5/8 inches (295 mm)**] long.
6. Application: Use for exposed brick unless otherwise indicated.
7. [**Where indicated to "match existing,"**] provide facing brick matching color range, texture, and size of existing adjacent brickwork.
8. Color and Texture: [**Medium brown, wire cut**][**Full-range red, sand molded**][**Buff, velour**][**Match Architect's samples**][**as directed by the Owner**] .

F. Solid Building Brick: ASTM C62, Grade [**SW**][**MW**][**NW**] .

1. Size (Actual Dimensions): [**3-1/2 inches (89 mm) wide by 2-1/4 inches (57 mm) high by 7-1/2 inches (190 mm) long**][**or**][**3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long**] .
2. Application: Use for concealed brick unless otherwise indicated.

G. Glazed Brick: ASTM C1405, Grade [**S**][**SS**] , Class [**Exterior**][**Interior**] , Division [**Solid**][**H40V**][**H60V**] .

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

    a. [**Belden Brick Company (The)**]
    b. [**Elgin Butler Company**]
    c. [**Glen-Gery Corporation**]

2. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by [**2-1/4 inches (57 mm)**][**2-3/4 inches (70 mm)**][**3-5/8 inches (92 mm)**][**7-5/8 inches (194 mm)**] high by [**7-5/8 inches (194 mm)**][**8 inches (203 mm)**][**11-5/8 inches (295 mm)**] long.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and provide Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Application: Use where [**brick is exposed unless otherwise**] indicated.
5. Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**] .
6. [**Where indicated to "match existing,"**] provide glazed brick matching color range, texture, and size of existing adjacent brickwork.

2.6 STRUCTURAL CLAY FACING TILE

A. General: Provide solid, multicored, or hollow units, with shape and direction of cores optional unless

otherwise indicated.

1. Where reinforced masonry is indicated, provide multicored units designed for use in reinforced, grouted masonry, either with vertical cores and with webs notched to receive horizontal reinforcement, or with horizontal cores and with holes in bed shells for placement of grout and to receive vertical reinforcement.
2. Where indicated for exterior applications, provide units recommended by manufacturer for exterior use in Project's location.
3. Provide special shapes where required for corners, jambs, coved bases, sills, and other special conditions indicated, including applications that cannot be produced by sawing standard units.

    a. Provide [**bullnose**][**square-edged**] units for outside corners unless otherwise indicated.
    b. Provide coved internal corners.
    c. Provide recessed, coved base units.

4. Where direct application of plaster is indicated or where bonded to backup masonry, provide units with rough, combed, or scored faces.

B. Glazed Structural Clay Facing Tile: ASTM C126, Grade [**S**][**SS**] .

1. Sizes: [**6P Series with actual face dimensions of 3-5/8 inches (92 mm) high by 11-5/8 inches (295 mm)**][**6T Series with actual face dimensions of 5 inches (127 mm) high by 11-11/16 inches (297 mm)**][**4W Series (8-Square) with actual face dimensions of 7-5/8 inches (194 mm) high by 7-5/8 inches (194 mm)**][**4S Series with actual face dimensions of 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm)**][**8W Series with actual face dimensions of 7-5/8 inches (194 mm) high by 15-5/8 inches (397 mm)**] long by widths indicated.
2. Width: Manufactured to dimensions [**5/16 inch (8 mm)**][**3/8 inch (10 mm)**] less than nominal dimensions.
3. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
4. Provide special units glazed on ends and tops, as well as faces for corners, jambs, sills, pilasters, columns, and other applications indicated, where glazed units are exposed on other surfaces and faces.
5. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**as directed by the Owner**].
6. [**Where shown to "match existing,"**] provide glazed structural clay facing tile matching color range, texture, and size of existing adjacent glazed structural clay facing tile.

C. Unglazed Structural Clay Facing Tile: ASTM C212, Type [**FTX**][**FTS**] , Class [**Standard**][**Special-Duty**] .

1. Number of Faces: Single faced [**where only one finished face is exposed when units are installed; double faced, where both finished faces are exposed when units are installed**] .
2. Size: [**As indicated**][**Match existing**] .

2.7 FIREPLACE AND CHIMNEY LINING UNITS

A. Firebox Brick: ASTM C1261, size required to produce lining thickness indicated.

B. Clay Flue Lining Units: ASTM C315.

2.8 LINTELS

A. Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density

classification; and with reinforcing bars indicated. [**Provide lintels with net-area compressive strength of not less than that of CMUs.**][**Provide lintels with net-area compressive strength as indicated.**]

B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete" and with reinforcing bars indicated.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

D. Offset Angle Supports: Steel plate brackets anchored to structure, allowing continuous insulation behind shelf angle supporting veneer. Component and anchor size and spacing engineered by manufacturer.

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

a. [**FERO Corporation**]
b. [**Halfen USA, Inc.**]
c. [**Hohmann & Barnard, Inc**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] .
3. Carbon Steel: ASTM A1008/A1008M [**with ASTM A153/A153M, Class B coating**] .

2.9 MORTAR AND GROUT MATERIALS

A. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

B. Regional Materials: Verify aggregate for mortar and grout [**cement, and lime**] is manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

C. General: Provide mortar and grout materials to achieve performance requirements as specified in mortar and grout mixes.

D. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

E. Hydrated Lime: ASTM C207, Type S.

F. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

G. Masonry Cement: ASTM C91/C91M.

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

a. [**Argos USA LLC**]
b. [**Cemex S.A.B. de C.V.**]
c. [**Fairborn Cement Company**]
d. [**Federal White Cement, Ltd.**]
e. [**Heidelberg Materials**]
f. [**Holcim (US) Inc**]
g. [**Lafarge North America Inc.**]
h. [**Lehigh White Cement Company**]
i. [**Quikrete; The QUIKRETE Companies, LLC**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]

H. Mortar Cement: ASTM C1329/C1329M.

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

a. [**Lafarge North America Inc.**]

I. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

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

a. [**Davis Colors**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Lanxess Corporation**]
d. [**Solomon Colors Inc.**]

J. Colored Mortar: Packaged blend made from [**portland cement-lime mix**][**or**][**masonry cement**] and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

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

1) [**Argos USA LLC**]
2) [**Heidelberg Materials**]

3) [**Holcim (US) Inc**]
4) [**Lafarge North America Inc.**]

2. Colored Masonry Cement:

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

1) [**Argos USA LLC**]
2) [**Cemex S.A.B. de C.V.**]
3) [**Fairborn Cement Company**]
4) [**Heidelberg Materials**]
5) [**Holcim (US) Inc**]
6) [**Lafarge North America Inc.**]

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments do not exceed 10 percent of portland cement by weight.
5. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.

K. Preblended Dry Mortar Mix: Packaged blend complying with ASTM C1714/C1714M.

1. Preblended Dry Portland Cement Mortar Mix:

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

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**Quikrete; The QUIKRETE Companies, LLC**]
3) [**Sakrete; CRH Americas, Oldcastle APG**]
4) [**SPEC MIX, LLC**]

b. Dry Mortar Mix Materials: Made from [**portland cement-lime mix**][**masonry cement**][**or**][**mortar cement**] , sand, [**mortar pigments,**][**water repellent admixture**] .

2. Preblended Dry Masonry Cement Mortar Mix:

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

1) [**Amerimix is a trademark of Bonsal American, an Oldcastle company**]
2) [**SPEC MIX, LLC**]

L. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6.4 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

M. Aggregate for Grout: ASTM C404.

N. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or prefaced masonry units (and approved for use by manufacturer of units); in color indicated or, if not otherwise indicated, as directed by the Owner.

O. Refractory Mortar Mix: Ground fireclay or nonwater-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C199 test; or an equivalent product acceptable to authorities having jurisdiction.

P. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with [**ASTM C494/C494M, Type C**][**ASTM C1384**] , and recommended by manufacturer for use in masonry mortar of composition indicated.

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

a. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
b. [**GCP Applied Technologies Inc.**]

Q. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

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

a. [**ACM Chemistries**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**GCP Applied Technologies Inc.**]
d. [**Master Builders Solutions**]

R. Water: Potable.

2.10 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60 (Grade 420)**.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold or lock more securely reinforcing bars in center of cells. Units are formed from minimum **0.148-inch (3.77-mm)** diameter steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

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

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Heckmann Building Products, Inc.**]
    c. [**Hohmann & Barnard, Inc**]
    d. [**Wire-Bond**]

C. Masonry-Joint Reinforcement: ASTM A951/A951M.

1. Interior Walls: [**Mill-**][**Hot-dip**] galvanized carbon steel.
2. Exterior Walls: [**Hot-dip galvanized carbon**][**Stainless**] steel.
3. Wire Size for Side Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
4. Wire Size for Cross Rods: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
5. Wire Size for Veneer Ties: [**0.148-inch (3.77-mm)**][**0.187-inch (4.76-mm)**] diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than **16 inches (406 mm)** o.c.
7. Provide in lengths of not less than **10 ft. (3 m)**[**with prefabricated corner and tee units**] .

D. Masonry-Joint Reinforcement for Single-Wythe Masonry:

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

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Hohmann & Barnard, Inc**]
    c. [**Wire-Bond**]

2. Type: Ladder [**or truss**] with single pair of side rods.

E. Masonry-Joint Reinforcement for Multiwythe Masonry:

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

    a. [**3GEN Masonry Products, Inc.**]
    b. [**Heckmann Building Products, Inc.**]
    c. [**Hohmann & Barnard, Inc**]
    d. [**Wire-Bond**]

2. Ladder type with one side rod at each face shell of hollow masonry units more than **4 inches (102 mm)** wide, plus [**one side rod**][**two side rods**] at each wythe of masonry **4 inches (102 mm)** wide or less.
3. Tab type, either ladder or truss design, with one side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least **5/8-inch (16-mm)** cover on outside face.
4. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of

backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of **1/16 inch (1.6 mm)** and maximum vertical adjustment of **1-1/4 inches (32 mm)**. Size ties to extend at least halfway through facing wythe but with at least **5/8-inch (16-mm)** cover on outside face. [**Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.**]

F. Masonry-Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single **0.187-inch- (4.76-mm-)** diameter, [**hot-dip galvanized carbon**][**stainless**] steel continuous wire.

2.11 TIES AND ANCHORS

A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into veneer but with at least a **5/8-inch (16-mm)** cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, [**Type 304**][**Type 316**] .
4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] .
7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
8. Stainless Steel Bars: ASTM A276 or ASTM A666/A666M, Type 304.

C. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 13 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.0336-inch- (0.85-mm-) thick steel sheet, galvanized after fabrication**][**0.0635-inch- (1.61-mm-) thick steel sheet, galvanized after fabrication**][**0.0312-inch- (0.79-mm-) thick, stainless steel sheet**][**0.0625-inch- (1.59 mm-) thick, stainless steel sheet**] .

D. Individual Wire Ties: Rectangular units with closed ends and not less than **4 inches (100 mm)** wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than **2 inches (51 mm)** long for masonry constructed from solid units.
2. Where wythes [**do not align**][**are of different materials**] , use adjustable ties with pintle-and-eye connections having a maximum adjustment of **1-1/4 inches (32 mm)**.
3. Wire: Fabricate from [**3/16-inch- (4.76-mm-)**][**1/4-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.**]

E. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

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

a. [**3GEN Masonry Products, Inc.**]

2. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch- (6.4-mm-)** diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
3. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]

F. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: [**Dovetail**][**Channel**] tabs for inserting into [**dovetail**][**channel**] slots in concrete and attached to tie section; formed from [**0.060-inch- (1.52-mm-) thick steel sheet, galvanized after fabrication**][**0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication**][**0.062-inch- (1.59-mm-) thick, stainless steel sheet**][**0.109-inch- (2.78-mm-) thick, stainless steel sheet**] .

    a. [**0.064-inch- (1.63-mm-)**][**0.108-inch- (2.74-mm-)**] thick, galvanized-steel sheet may be used at interior walls unless otherwise indicated.

2. Tie Section: Triangular-shaped wire tie made from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized steel**][**stainless steel**] wire. [**Mill-galvanized wire may be used at interior walls unless otherwise indicated.**]
3. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 13 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from [**0.0635-inch- (1.61-mm-) thick steel sheet, galvanized after fabrication**][**0.0785-inch- (1.99 mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0625-inch- (1.59-mm-) thick, stainless steel sheet**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] with [**dovetail**][**channel**] tabs for inserting into slots in concrete.

    a. [**0.064-inch- (1.63-mm-)**][**0.079-inch- (2.01-mm-)**][**0.108-inch- (2.74-mm-)**] thick galvanized sheet may be used at interior walls unless otherwise indicated.

G. Partition Top Anchors: **0.105-inch- (2.66-mm-)** thick metal plate with a **3/8-inch- (10-mm-)** diameter metal rod **6 inches (152 mm)** long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from [**steel, hot-dip galvanized after fabrication**][**stainless steel**] .

H. Rigid Anchors: Fabricate from steel bars [**1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated**][**bent to configuration indicated**] .

1. Corrosion Protection: [**Hot-dip galvanized to comply with ASTM A153/A153M**][**Epoxy coating 0.020 inch (0.51 mm) thick**][**Rust-inhibitive paint**] .

I. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a **100 lbf (445 N)** load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of **1/16 inch (1.6 mm)**.
2. Fabricate sheet metal anchor sections and other sheet metal parts from [**0.0785-inch- (1.99-mm-) thick steel sheet, galvanized after fabrication**][**0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication**][**0.0781-inch- (1.98-mm-) thick, stainless steel sheet**][**0.1094-inch- (2.78-mm-) thick, stainless steel sheet**] .

3. Fabricate wire ties from [**0.187-inch- (4.76-mm-)**][**0.25-inch- (6.4-mm-)**] diameter, [**hot-dip galvanized-steel**][**stainless steel**] wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie with seismic accessories [**and washer at face of insulation**] .

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

        1) [**3GEN Masonry Products, Inc.**]
        2) [**FERO Corporation**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**PROSOCO, Inc**]
        5) [**Wire-Bond**]

6. Masonry-Veneer Anchors; Double-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting horizontal leg with slots for vertical legs of double pintle wire tie.

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

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Heckmann Building Products, Inc.**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**Quality Steel and Wire LLC**]
        5) [**Wire-Bond**]

    b. Seismic: Provide seismic tie, clip, and continuous wire in veneer.

7. Masonry-Veneer Anchors; Slotted Plate: Sheet metal anchor section, with screw holes at top and bottom; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

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

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Heckmann Building Products, Inc.**]
        3) [**Hohmann & Barnard, Inc**]
        4) [**Quality Steel and Wire LLC**]
        5) [**Wire-Bond**]

8. Masonry-Veneer Anchors; Slotted Plate with Prongs: Sheet metal anchor section, with screw holes at top and bottom; top and bottom ends bent to form pronged legs of length to match

thickness of insulation; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. [**Use self-adhering tape to seal penetration behind anchor plate.**]

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

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

9. Masonry-Veneer Anchors; Single-Barrel Screw: Self-drilling, single-barrel screw designed to receive wire tie. Screw has a smooth barrel the same thickness as insulation.

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

1) [**3GEN Masonry Products, Inc.**]
2) [**Heckmann Building Products, Inc.**]
3) [**Hohmann & Barnard, Inc**]
4) [**PROSOCO, Inc**]
5) [**TruFast; a brand of Altenloh, Brinck & Co. US, Inc.**]
6) [**Wire-Bond**]

b. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
c. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

10. Masonry-Veneer Anchors; Single-Barrel Screw with Double-Pintle Wingnut: Self-drilling, single-barrel screw with wingnut or clip designed to receive double-pintle wire tie. Screw has a smooth barrel the same thickness as insulation.

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

1) [**Heckmann Building Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]

b. Fastener Configuration: Single-barrel screw with [**wingnut head**][**thermally resistant wingnut head**][**thermally resistant clip**] .
c. Factory Options: Provide factory-installed gasketed washer to seal at face of insulation and sheathing [**and a coating to reduce thermal conductivity**] .
d. Seismic: Provide with seismic tie, clip, and continuous wire in veneer.

11. Masonry-Veneer Anchors; Seismic-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting leg with slotted hole for vertical leg of seismic pintle tie. Tie is rib-stiffened, sheet metal bent plate with down-turned leg to fit in anchor slot and with

integral tabs to hold continuous wire in veneer.

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

1) [**Hohmann & Barnard, Inc**]
2) [**Wire-Bond**]

12. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours in accordance with ASTM B117.
13. Stainless Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, **No. 10 (4.83 mm)** diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon-steel drill point and 300 Series stainless steel shank.

2.12 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual."

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

a. [**3GEN Masonry Products, Inc.**]
b. [**Cheney Flashing Company**]
c. [**Hohmann & Barnard, Inc**]
d. [**Keystone Flashing Company, Inc**]
e. [**Wire-Bond**]

2. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
3. Copper: [**ASTM B370, Temper H00, cold-rolled copper sheet, 16 oz./sq. ft. (4.9 kg/sq. m) weight or 0.0216 inch (0.55 mm) thick**][**or**][**ASTM B370, Temper H01, high-yield copper sheet, 12 oz./sq. ft. (3.7 kg/sq. m) weight or 0.0162 inch (0.41 mm) thick**] .
4. Fabricate continuous flashings in sections **96 inches (2438 mm)** long minimum, but not exceeding **12 ft. (3.7 m)**. Provide splice plates at joints of formed, smooth metal flashing.
5. Fabricate through-wall metal flashing embedded in masonry from [**stainless steel**][**copper**] , with sawtooth ribs at **3-inch (76-mm)** intervals along length of flashing to provide an integral mortar bond.
6. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
7. Fabricate through-wall flashing with drip edge [**where**][**unless otherwise**] indicated. Fabricate by extending flashing **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
8. Fabricate through-wall flashing with sealant stop [**where**][**unless otherwise**] indicated. Fabricate by bending metal back on itself **3/4 inch (19 mm)** at exterior face of wall and down into joint **1/4 inch (6.4 mm)** to form a stop for retaining sealant backer rod.

9. Fabricate metal [**drip edges**][**and**][**sealant stops**] for sawtooth metal flashing from plain metal flashing of same metal as sawtooth flashing and extending at least **3 inches (76 mm)** into wall with hemmed inner edge to receive sawtooth flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
10. Fabricate metal drip edges from stainless steel. Extend at least **3 inches (76 mm)** into wall and **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees [**and hemmed**] .
11. Fabricate metal sealant stops from stainless steel. Extend at least **3 inches (76 mm)** into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for **3/4 inch (19 mm)** and down into joint **1/4 inch (6.4 mm)** to form a stop for retaining sealant backer rod.
12. Fabricate metal expansion-joint strips from [**stainless steel**][**copper**] to shapes indicated.
13. Solder metal items at corners.

B. Flexible Flashing: Where flashing is fully concealed in masonry, use one of the following unless otherwise indicated:

1. Copper-Fabric Flashing: Copper sheet bonded between two layers of glass-fiber cloth.

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

      1) [**Advanced Building Products Inc.**]
      2) [**Hohmann & Barnard, Inc**]
      3) [**STS Coatings, Inc.**]
      4) [**Wire-Bond**]
      5) [**York Manufacturing, Inc**]

   b. Sheet Weight: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .
   c. Sheet Type: [**Non-adhesive**][**Self-adhesive**] .

2. Asphalt-Coated Copper Flashing: Copper sheet coated with flexible asphalt.

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

      1) [**Hohmann & Barnard, Inc**]
      2) [**Wire-Bond**]

   b. Sheet Weight: [**5 oz./sq. ft. (1.5 kg/sq. m)**][**7 oz./sq. ft. (2 kg/sq. m)**] .

3. Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

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

      1) [**3GEN Masonry Products, Inc.**]

2) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
3) [**Hohmann & Barnard, Inc**]
4) [**PROSOCO, Inc**]
5) [**STS Coatings, Inc.**]
6) [**Wire-Bond**]
7) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Overall Thickness: Manufacturer's standard.

4. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of minimum **2-mil- (0.05-mm-)** thick stainless steel sheet, bonded to a layer of polymeric fabric.

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

1) [**3GEN Masonry Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**STS Coatings, Inc.**]
4) [**VaproShield LLC**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Grade: [**Type 304**][**Type 316**] .
c. Bonding Agent: [**Butyl**][**Permanent, clear**] adhesive.
d. Overall Thickness: Manufacturer's standard.

5. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film.

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

1) [**Advanced Building Products Inc.**]
2) [**Carlisle Coatings & Waterproofing Inc**]
3) [**Fiberweb, a brand of Clark/Hammerbeam Corp.**]
4) [**GCP Applied Technologies Inc.**]
5) [**Heckmann Building Products, Inc.**]
6) [**Hohmann & Barnard, Inc**]
7) [**Polyguard Products, Inc.**]
8) [**W. R. Meadows, Inc**]
9) [**Williams Products, Inc.**]
10) [**Wire-Bond**]
11) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**30 mils (0.76 mm)**][**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] .

6. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl

rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin.

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

1) [**DuPont de Nemours, Inc.**]
2) [**GCP Applied Technologies Inc.**]
3) [**Kingspan Insulation LLC**]
4) [**Protecto Wrap Company**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Overall Thickness: Not less than [**35 mils (0.89 mm)**][**40 mils (1.0 mm)**] .

7. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

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

1) [**3GEN Masonry Products, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Hyload; IKO Industries, Inc.**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]

b. Monolithic Sheet: Elastomeric thermoplastic flashing, **40 mils (1.0 mm)** thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, **25 mils (0.64 mm)** thick, with a **15-mil- (0.38-mm-)** thick coating of adhesive.

1) Color: [**Gray**][**White**][**Tan/buff**][**Black**] .

8. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M.

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

1) [**Carlisle Coatings & Waterproofing Inc**]
2) [**Elevate; Amrize Building Envelope LLC**]
3) [**Heckmann Building Products, Inc.**]
4) [**Hohmann & Barnard, Inc**]
5) [**Wire-Bond**]

b. Thickness: **40 mils (1.0 mm)**.

C. Drainage Plane Flashing: Provide flashing materials as follows:

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

   a. [**3GEN Masonry Products, Inc.**]
   b. [**Mortar Net Solutions**]
   c. [**STS Coatings, Inc.**]
   d. [**York Manufacturing, Inc**]

2. Fabrication: [**Stainless steel**][**Copper**][**Rubberized asphalt**][**Elastomeric membrane**] and drainage membrane to shapes indicated [**including weep tabs, termination bar, and drip edge**] .

   a. Stainless Steel: ASTM A240/A240M or ASTM A666/A666M, [**Type 304**][**Type 316**] , **0.016 inch (0.40 mm)** thick.
   b. Copper: [**3 oz./sq. ft. (0.9 kg/sq. m)**][**5 oz./sq. ft. (1.5 kg/sq. m)**] thick.
   c. Rubberized Asphalt: [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.
   d. Elastomeric Membrane: [**EPDM complying with ASTM D4637/D4637M**][**PVC**][**PVC with Elvaloy Kee**][**TPO**] , [**40 mils (1.0 mm)**][**60 mils (1.5 mm)**] thick.

3. Fabricate continuous flashings in sections **60 inches (1524 mm)** long, minimum.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

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

   a. [**Mortar Net Solutions**]

E. Preformed Corners, End Dams, and Seaming Shapes for Flashing: Flashing manufacturer's standard products or products recommended by flashing manufacturer for waterproofing openings.

F. Solder and Sealants for Sheet Metal Flashings: [**As specified in Section 076200 "Sheet Metal Flashing and Trim."**]

1. Solder for Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
2. Solder for Copper: ASTM B32, [**Grade Sn50**][**with maximum lead content of 0.2 percent**] .
3. Elastomeric Sealant: ASTM C920, chemically curing [**urethane**][**polysulfide**][**silicone**] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

G. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

H. Termination Bars for Flexible Flashing:

1. Material: [**Aluminum**][**Stainless steel**][**Rigid PVC**]
2. Size: [**0.075 by 1 inch (1.90 by 25 mm)**][**1/8 by 1 inch (3.2 by 25 mm)**][**1/8 by 1-1/8 inch (3.2 by 29 mm)**] .

I. Termination Bars for Flexible Flashing, Flanged:

1. Material: [**Stainless steel sheet 0.019 by 1-1/2 inches (0.48 by 38 mm)**][**Aluminum sheet 0.064 by 1-1/2 inches (1.63 by 38 mm)**] .
2. Fabricate with a **3/8-inch (10-mm)** flange at top [**and bottom**] .

2.13 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [**neoprene**][**urethane**][**or**][**PVC**] .

B. Preformed Control-Joint Gaskets: Made from [**styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805**][**or**][**PVC, complying with ASTM D2287, Type PVC-65406**] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

D. Weep/Cavity Vents: Use one of the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton, **1/4 to 3/8 inch (6.4 to 10 mm)** in diameter, in length required to produce **2-inch (51-mm)** exposure on exterior and **18 inches (457 mm)** in cavity. Use only for weeps.
2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, **3/8-inch (10-mm)** OD by **4 inches (102 mm)** long.
3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, **3/8 by 1-1/2 by 3-1/2 inches (10 by 38 by 89 mm)** long.
4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe, in color selected from manufacturer's standard.

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

        1) [**3GEN Masonry Products, Inc.**]
        2) [**Advanced Building Products Inc.**]
        3) [**Heckmann Building Products, Inc.**]
        4) [**Hohmann & Barnard, Inc**]
        5) [**Mortar Net Solutions**]
        6) [**Wire-Bond**]

5. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth **1/8 inch (3.2 mm)** less than depth of outer wythe; in color selected from manufacturer's standard.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

1) [**CavClear; a division of Archovations, Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]

6. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color, as directed by the Owner.

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

1) [**Hohmann & Barnard, Inc**]
2) [**Williams Products, Inc.**]
3) [**Wire-Bond**]

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Mortar Deflector:

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

1) [**Advanced Building Products Inc.**]
2) [**Hohmann & Barnard, Inc**]
3) [**Keene Building Products**]
4) [**Mortar Net Solutions**]
5) [**Wire-Bond**]
6) [**York Manufacturing, Inc**]

b. Size: Strips [**full depth of cavity**][**3/4 inch (19 mm) thick**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] and [**10 inches (254 mm)**][**16 inches (406 mm)**] high.

c. Surface Drainage: [**Dovetail-shaped notches**][**Dimpled surface**] that prevents clogging with mortar droppings.

2. Rainscreen Drainage Mat:

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

1) [**Advanced Building Products Inc.**]
2) [**CavClear; a division of Archovations, Inc.**]

3) [**Keene Building Products**]
4) [**Maxxon Corporation**]
5) [**Mortar Net Solutions**]
6) [**Wire-Bond**]

b. Size: Sheets or strips not less than [**full depth of cavity**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm) thick**][**2 inches (51 mm)**] thick and installed to full height of cavity.
c. Surface Drainage: Provide additional strips **4 inches (102 mm)** high at weep holes and thick enough to fill entire depth of cavity to prevent weep holes from clogging with mortar.

F. Masonry Cell Fill: [**Loose-Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation)**][**Lightweight-Aggregate Fill: ASTM C331/C331M**][**Foamed-in-place masonry cell fill**] .

G. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

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

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**EaCo Chem, Inc.**]
c. [**PROSOCO, Inc**]

2.14 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar unless otherwise indicated.
3. For exterior masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
4. For reinforced masonry, use [**portland cement-lime**][**masonry cement**][**or**][**mortar cement**] mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, [**Proportion**][**Property**] Specification. Provide the following types of mortar for applications stated unless another type is indicated [**or needed to provide required compressive strength of masonry**] .

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use [**Type M**][**Type S**][**Type N**] .
3. For mortar parge coats, use [**Type S**][**or**][**Type N**] .
4. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior nonload-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product [**or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored mortar cement**] .

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Pigments do not exceed 5 percent of [**masonry cement**][**or**][**mortar cement**] by weight.
3. Mix to match Architect's sample.
4. Application: Use pigmented mortar for exposed mortar joints, as directed by the Owner.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints, as directed by the Owner.

F. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 402/602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, [**Table 1**][**or**][**paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa)**] .
3. Provide grout with a slump of [**8 to 11 inches (203 to 279 mm)**][**10 to 11 inches (254 to 279 mm)**] as measured in accordance with ASTM C143/C143M.

G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

1. Application: Use epoxy pointing mortar for exposed mortar joints, as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (13 mm)** or minus **1/4 inch (6.4 mm)**.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (13 mm)**.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6.4 mm)** in a story height or **1/2 inch (13 mm)** total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.6 mm)** except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**, with a maximum thickness limited to **1/2 inch (13 mm)**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3.2 mm)**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (10 mm)** or minus **1/4 inch (6.4 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**. [**Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3.2 mm).**]
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than **1/16 inch (1.6 mm)** from one masonry unit to the next.

3.4 INSTALLATION OF MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [**running bond**][**stack bond**][**one-third running bond**][**Flemish bond**][**English bond**][**bond pattern indicated on Drawings**] ; do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than [**2 inches (51 mm)**][**4 inches (102 mm)**] . Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-In Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout **24 inches (610 mm)** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Rigid, Cellular Thermal Insulation, CMUs: Install molded-polystyrene insulation units into masonry unit cells before laying units.

J. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of hollow CMUs solidly around plastic tubes of anchors, and push tubes down into grout to provide **1/2-inch (13-mm)** clearance between end of anchor rod and end of tube. Space anchors [**48 inches (1219 mm)**] o.c. unless otherwise indicated.

3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 INSTALLATION OF MORTAR BEDDING AND JOINTING

A. General: Lay masonry units as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Hollow Clay Facing Brick: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Solid Masonry Units: Lay units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

D. Structural Clay Facing Tiles: Lay units as follows:

1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with **1/4- to 3/8-inch- (6.4- to 10-mm-)** thick joints.

E. Firebox Brick: Set units in full bed of refractory mortar with full head joints. Form joints by buttering both surfaces of adjoining brick and sliding it into place. Make joints just wide enough to accommodate variations in size of brick, approximately **1/8 inch (3.2 mm)**. Tool joints smooth on surfaces exposed to fire or smoke.

F. Clay Flue Lining Units: Install units to comply with ASTM C1283. Install flue liners ahead of surrounding masonry. Set clay flue liners in full bed of refractory mortar **1/16 to 1/8 inch (1.6 to 3.2 mm)** thick. Strike joints flush on inside of flue to provide smooth surface. Maintain expansion space between flue liner and surrounding masonry except where surrounding masonry is required to provide lateral support for flue liners.

G. Trim Units: Set [**stone**][**cast-stone**] trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.
4. Rake out mortar joints for pointing with sealant.

H. Rake out mortar joints at [**prefaced CMUs**][**glazed brick**][**and**][**glazed structural clay facing tile**] to a

uniform depth of **1/4 inch (6.4 mm)** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

I. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer **3/4 inch (19 mm)** or more in width.

J. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

K. Cut joints flush where indicated to receive [**waterproofing**][**cavity wall insulation**][**air barriers**] unless otherwise indicated.

3.6 INSTALLATION OF COMPOSITE MASONRY

A. Bond wythes of composite masonry together [**using one of the following methods**][**as follows**] :

1. Individual Wire Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for [**4.5 sq. ft. (0.42 sq. m)**][**2.67 sq. ft. (0.25 sq. m)**][**1.77 sq. ft. (0.16 sq. m)**] of wall area spaced not to exceed [**36 inches (914 mm)**][**24 inches (610 mm)**][**16 inches (406 mm)**] o.c. horizontally and **16 inches (406 mm)** o.c. vertically. Stagger ties in alternate courses. Provide additional ties within **12 inches (305 mm)** of openings and space not more than **36 inches (914 mm)** apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than **24 inches (610 mm)** o.c. vertically.

a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.

2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

a. Where bed joints of both wythes align, use [**ladder-type reinforcement extending across both wythes**][**tab-type reinforcement**] .
b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] .

3. Header Bonding: Provide masonry unit headers extending not less than **3 inches (76 mm)** into each wythe. Space headers not more than [**8 inches (200 mm)**][**12 inches (300 mm)**] clear horizontally and **16 inches (400 mm)** clear vertically.

B. Bond wythes of composite masonry together using bonding system indicated on Drawings.

C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.

1. Structural Clay Facing Tile: After each course is laid, fill the vertical, longitudinal joint between wythes solidly with mortar at [**exterior walls, except cavity walls**][**and**][**interior walls and partitions**] .

D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.

1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.

E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are indicated at juncture, bond walls together as follows:

1. Provide individual wire ties not more than [**8 inches (203 mm)**][**16 inches (406 mm)**] o.c.
2. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.
3. Provide rigid metal anchors not more than [**24 inches (610 mm)**][**48 inches (1219 mm)**] o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 INSTALLATION OF CAVITY WALLS

A. Bond wythes of cavity walls together as follows:

1. Individual Wire Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for [**4.5 sq. ft. (0.42 sq. m)**][**2.67 sq. ft. (0.25 sq. m)**][**1.77 sq. ft. (0.16 sq. m)**] of wall area spaced not to exceed [**36 inches (914 mm)**][**24 inches (610 mm)**][**16 inches (406 mm)**] o.c. horizontally and **16 inches (406 mm)** o.c. vertically. Stagger ties in alternate courses. Provide additional ties within **12 inches (305 mm)** of openings and space not more than **36 inches (914 mm)** apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than **24 inches (610 mm)** o.c. vertically.

   a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.
   b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) ties to allow for differential movement regardless of whether bed joints align.

2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

   a. Where bed joints of both wythes align, use [**ladder-type reinforcement extending across both wythes**][**tab-type reinforcement**] .
   b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] .
   c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] to allow for differential movement regardless of whether bed joints align.

3. Header Bonding: Provide masonry unit headers extending not less than **3 inches (76 mm)** into each wythe. Space headers not more than [**8 inches (203 mm)**][**12 inches (305 mm)**] clear horizontally and **16 inches (406 mm)** clear vertically.
4. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Bond wythes of cavity walls together using bonding system indicated on Drawings.

C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

D. Parge cavity face of backup wythe in a single coat approximately **3/8 inch (10 mm)** thick. Trowel face of parge coat smooth.

E. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately **12 inches (305 mm)** o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as indicated.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.8 INSTALLATION OF ANCHORED MASONRY VENEERS

A. Masonry-veneer anchors to comply with the following requirements:

1. Fasten [**screw-attached**][**and**][**seismic**] anchors [**through sheathing to wall framing**][**and**][**to concrete and masonry backup**] with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed [**tie sections**][**connector sections and continuous wire**] in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and **24 inches (610 mm)** o.c. horizontally, with not less than one anchor for each **2 sq. ft. (0.2 sq. m)** of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **8 inches (203 mm)**, around perimeter.
5. Space anchors as indicated, but not more than **16 inches (406 mm)** o.c. vertically and **25 inches (635 mm)** o.c. horizontally, with not less than one anchor for each [**2.67 sq. ft. (0.25 sq. m)**][**3.5 sq. ft. (0.33 sq. m)**] of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **36 inches (914 mm)**, around perimeter.
6. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and horizontally. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **24 inches (610 mm)**, around perimeter.

B. Provide not less than [**2 inches (51 mm)**][**1 inch (25 mm)**] of airspace between back of masonry veneer and face of [**sheathing**][**insulation**] .

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.9 INSTALLATION OF MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of **5/8 inch (16 mm)** on exterior side of walls, **1/2 inch (13 mm)** elsewhere. Lap reinforcement a minimum of **6 inches (152 mm)**.

1. Space reinforcement not more than **16 inches (406 mm)** o.c.
2. Space reinforcement not more than **8 inches (203 mm)** o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than **8 inches (203 mm)** above and below wall openings and extending **12 inches (305 mm)** beyond openings [**in addition to continuous reinforcement**] .

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at [**corners,**] returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 INSTALLATION OF ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than [1/2 inch (13 mm)][1 inch (25 mm)][2 inches (51 mm)] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (914 mm) o.c. horizontally.

3.11 INSTALLATION OF CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Indicate locations of joints on Drawings. Form control joints in concrete masonry as follows:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches (102 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than [3/8 inch (10 mm)][1/2 inch (13 mm)] for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than [3/8 inch (10 mm)] .

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.12 INSTALLATION OF LINTELS

A. Provide lintel types where indicated on Drawings and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are indicated without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches (203 mm) at each jamb unless otherwise indicated.

3.13 INSTALLATION OF EMBEDDED FLASHING

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. [**Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.**]

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape [**as recommended by flashing manufacturer**] .
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of [**4 inches (102 mm)**][**8 inches (203 mm)**] , and through inner wythe to within **1/2 inch (13 mm)** of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately **2 inches (51 mm)** on interior face.
3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of [**4 inches (102 mm)**][**8 inches (203 mm)**] , and **1-1/2 inches (38 mm)** into the inner wythe. [**Form 1/4-inch (6.4-mm) hook in edge of flashing embedded in inner wythe.**]
4. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least **8 inches (203 mm)**; with upper edge tucked under [**water-resistive barrier**][**air barrier**] , lapping at least **4 inches (102 mm)**. [**Fasten upper edge of flexible flashing to sheathing through termination bar.**]
5. At lintels and shelf angles, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] at each end. At heads and sills, extend flashing **6 inches (152 mm)** minimum [**to edge of next full unit**] and turn ends up not less than **2 inches (51 mm)** to form end dams.
6. Interlock end joints of sawtooth sheet metal flashing by overlapping ribs not less than **1-1/2 inches (38 mm)** or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
7. Install metal [**drip edges**][**and**][**sealant stops**] with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
8. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
9. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
10. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Single-Wythe CMU Flashing System: Install in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.

3.14 INSTALLATION OF WEEP/CAVITY VENTS

A. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use [**specified weep/cavity vents**][**or**][**open-head joints**] to form weep holes.

2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes **24 inches (610 mm)** o.c. unless otherwise indicated.
4. Space weep holes formed from [**plastic tubing**][**or**][**wicking material**] **16 inches (406 mm)** o.c.
5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Trim wicking material flush with outside face of wall after mortar has set.

B. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than **2 inches (51 mm)**, to maintain drainage.

1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than **24 inches (610 mm)** above top of pea gravel.

C. Cavity Drainage Material: Place in [**cavities**][**airspace behind veneers**] to comply with configuration requirements for cavity drainage material in "Accessories" Article.

D. Install cavity vents in head joints in exterior wythes at spacing indicated. Use [**specified weep/cavity vent**][**or**][**open-head joints**] to form cavity vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.15 INSTALLATION OF REIINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 402/602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than [**60 inches (1524 mm)**][**12.67 ft. (3.86 m)**] .

3.16 INSTALLATION OF MASONRY CELL FILL

A. Loose-Fill Insulation: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft. (6 m)**.

B. Lightweight-Aggregate Fill: Pour into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft. (6 m)**.

C. Foamed-in-Place Masonry Cell Fill: Drill holes in mortar bed joints at spacing as indicated in writing by foamed-in-place masonry fill manufacturer, and inject foam to fill masonry cell voids.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: [**The Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Inspections: Special inspections in accordance with [**Level 2**][**Level 3**] in TMS 402/602.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each **5000 sq. ft. (464 sq. m)** of wall area or portion thereof.

E. Concrete Masonry Units: Test each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Clay Masonry Units: Test each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

G. Mortar Aggregates: Ratio test (Proportion Specification) for each mix provided, in accordance with ASTM C780.

H. Mortar: Test each mix provided in accordance with ASTM C780. Test mortar for [**mortar air content**][**and**][**compressive strength**] .

I. Grout: Test each mix provided in accordance with ASTM C1019.

J. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at [**7 days and at**] 28 days.

3.18 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of **3/4 inch (19 mm)**. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of **1/8 inch per foot (3.2 mm per 305 mm)**. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.19 REPAIRING AND POINTING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

3.20 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry, as directed by the Owner.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in TEK 08-04A.
7. Clean masonry with a proprietary acidic masonry cleaner applied in accordance with manufacturer's written instructions.

3.21 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than **4 inches (102 mm)** in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within **18 inches (457 mm)** of finished grade.

C. Masonry Waste Recycling: Return broken masonry units not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 01 54 23 00A

Task	Specification	Specification Description
01 54 23 00	01 00 00 00	General Requirements
01 54 23 00	01 22 00 00	No Specification Required
01 54 26 00	01 00 00 00	General Requirements
01 54 26 00	01 22 00 00	No Specification Required
01 55 00 00	01 00 00 00	General Requirements
01 55 23 00	01 00 00 00	General Requirements
01 55 23 00	01 22 00 00	No Specification Required

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SECTION 01 55 26 00 - PARKING CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Automatic barrier gates.
2. Vehicle detectors.
3. Traffic controllers.
4. Entry terminals.
5. Exit terminals.
6. Pay stations.
7. Fee computers.
8. Miscellaneous parking control equipment.
9. Parking facility management software.
10. Access control units.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for pipe bollards to protect parking control equipment.
2. Section 133423.16 "Fabricated Control Booths" for cashiers'/parking attendants' booths.
3. Section 281300 "Access Control Software and Database Management" for integrating parking control equipment with building access control.
4. Section 281500 "Access Control Hardware Devices" for parking control equipment access devices.
5. Section 283100 "Intrusion Detection" for integrating parking control equipment with the building intrusion detection system.
6. Section 283121 "Area and Perimeter Intrusion Detection" for integrating parking control equipment with the site security control system.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Verify that equipment operation is consistent with system description.
3. Review sequence of operation for each type of parking control equipment.
4. Review coordination of interlocked equipment specified in this Section and elsewhere.
5. Review required testing, inspecting, and certifying procedures.
6. <**Insert requirement**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for parking control equipment.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties.

B. Shop Drawings: For parking control equipment.

1. Include plans, elevations, sections and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Vehicle Detectors: Layout and method of placement of vehicle loop detector system.

C. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** square in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each type of exposed finish **6 inches (150 mm)** square in size.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For parking control equipment to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On [**USB media**][**and**][**approved online or cloud solution**].
3. Device address list.
4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Gate Arms: [**Two**]<**Insert number**> breakaway gate arms for each gate installed, complete with accessory components.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Parking Control System: For the following types of parking management:

1. Transient Parking: Hourly rated parking, with fee paid while [**entering**][**exiting**].
2. Monthly Parking: Monthly rated parking, with fee paid by the month and access gained by access control card.
3. Flat-Rate Parking: Unlimited-duration parking, with free gate entry and fixed-fee amount paid while exiting.
4. Flat-Rate or Hourly Parking: Fee paid at central pay station after parking.
5. Special-Event Parking: Duration-of-event parking, with fee paid while entering with gates up or down.
6. Limited Date and Time Parking: Limited-duration parking, with predetermined fee access control card.
7. Merchant Validated Parking: Fee set, reduced, or waived by merchant validation, with free gate entry and fee paid while exiting.
8. Valet Parking: Assisted parking, with fee paid while entering or exiting.
9. Hotel Guest Parking: Unlimited access for duration of stay, with access gained by access control card.

B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SOURCE LIMITATIONS

A. Obtain [**parking control equipment**]<**Insert equipment**> from single source from single manufacturer.

2.3 AUTOMATIC BARRIER GATES

A. Automatic Barrier Gates: Provide parking control device consisting of operator and controller housed in a weathertight, tamper-resistant cabinet enclosure with gate arm. Device shall be activated by a signal from access or revenue control device. Fabricate unit with gate-arm height in down position of not more than **35 inches (889 mm)** above pavement.

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

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Automatic Systems**]
d. [**CAME Americas Automation LLC**]
e. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
f. [**Delta Scientific Corporation**]
g. [**DoorKing, Inc**]
h. [**Engineered Parking Systems, Inc**]
i. [**Falcon Eye Global Security, LLC**]
j. [**Hy-Security Gate, Inc.; Nice North America; Nice group**]
k. [**Magnetic AutoControl USA**]
l. [**Parking Systems, Inc.**]

m. **<Insert manufacturer's name>**

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

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Automatic Systems**]
   d. [**CAME Americas Automation LLC**]
   e. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   f. [**Delta Scientific Corporation**]
   g. [**DoorKing, Inc**]
   h. [**Engineered Parking Systems, Inc**]
   i. [**Falcon Eye Global Security, LLC**]
   j. [**Hy-Security Gate, Inc.; Nice North America; Nice group**]
   k. [**Magnetic AutoControl USA**]
   l. [**Parking Systems, Inc.**]
   m. **<Insert manufacturer's name>**

3. Standards: Barrier gate operators that are listed and labeled according to UL 325 by a qualified testing agency.

B. Controller: Factory-sealed, solid-state, plug-in type, with galvanized-steel box for wiring connections. [**Noncommunicating**][**Communicating**] type.

1. Noncommunicating Type:

   a. Capable of logic for one- and two-way lanes.
   b. Separate momentary contacts for transient patrons, monthly patrons, vehicle entries, and vehicle exits.

2. Communicating Type:

   a. Real-time communication of lane counts, status messages, and execute commands.
   b. Monitor illegal entries and exits, tailgates, tickets, monthlies, and backouts.
   c. Status messages for gate up too long, backouts, ticket in chute, and gate-arm rebound.
   d. Communication commands for resetting loops, turning "Full" signs on/off, raising and lowering gate arm, and disabling [**ticket dispensers**][**card readers**][**barcode imagers**][**license plate recognition**][**automatic vehicle identification**].

3. Physical Characteristics:

   a. On-off power supply switch.
   b. Automatic-manual switch.
   c. Differential counter.
   d. Communication port.
   e. Internal [**resettable**][**non-resettable**] counters.
   f. Thermal-overload protection with manual reset.
   g. Plug-in connectors for [**two**][**three**] vehicle loop detectors.
   h. Thermostatically controlled heater with on/off/auto switch.
   i. Thermostatically controlled fan with on/off/auto switch.
   j. Switch to test motor and limit switches.
   k. Emergency manual disconnect.
   l. Battery backup.

m. [**Single**][**Two**][**Four**], 115-V ac grounded power receptacle.

4. Operational Characteristics:

a. Able to store successive inputs and sequentially processing each one.
b. Automatic instant-reversing obstacle detector mechanism that stops downward motion of gate arm if arm contacts or nears an object and that immediately returns arm to upward position. Include a zero- to 60-second, variable-time reset device.
c. Directional arming logic.
d. Broken gate-arm monitoring.
e. Programmable[**automatic**] timer.
f. Diagnostic mode for on-site testing[**, with LEDs for inputs and outputs**].
g. Automatic and continuous testing of inputs and outputs.
h. Reversible arm capability for right- or left-handed operation.

C. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; approximately **15 inches square by 40 inches tall (381 mm square by 1016 mm tall)**. Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish [**two**]<**Insert number**> keys for each lock[**, all locks keyed alike**]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

1. Steel Sheet: Not less than **0.097-inch- (2.5-mm-)** thick[**, galvanized-**] steel sheet.

a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**]<**Insert color**> baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch- (3.2-mm-)** thick, aluminum sheet.

a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**]<**Insert color**> baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch- (2.8-mm-)** thick, stainless-steel sheet.

a. Finish cabinet exterior with No. 4 finish.

D. Straight Gate Arm: [**1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood**][**0.097-inch- (2.5-mm-) thick steel**][**Fiberglass, PVC, or polycarbonate**][**Aluminum**].

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**10 feet (3.0 m)**][**12 feet (3.7 m)**][**As indicated on Drawings**]<**Insert length**>.
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

E. Folding Gate Arm: Two pieces of **1-by-4-inch nominal- (19-by-89-mm actual-)** size pine or redwood joined together with metal side brackets.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**10 feet (3.0 m)**][**12 feet (3.7 m)**][**As indicated on Drawings**]<**Insert length**>.
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

F. Straight Gate Arm with Counterbalance: **1-by-6-inch nominal- (19-by-140-mm actual-)** size pine or

redwood with steel counterweights.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**16 feet (4.9 m)**][**As indicated on Drawings**]<**Insert length**>.
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

G. Wishbone-Style Gate Arm: [**1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood**][**0.097-inch- (2.5-mm-) thick steel**] formed into wishbone configuration, with steel counterweights.

1. Traffic-Side Face: [**Reflective painted finish and black diagonal stripes**][**Reflective painted finish and red diagonal stripes**][**Reflective painted finish and black and yellow diagonal stripes**][**Manufacturer's standard finish and striping**].
2. Length: [**14 feet (4.3 m)**][**As indicated on Drawings**]<**Insert length**>.
3. Mounting Flange: Provide with breakaway feature to ensure a clean break if arm is struck by vehicle.

H. Operator: UL labeled and listed, [**Class I**][**Class II**][**Class III**][**Class IV**]. [**1/3**][**1/2**] hp; <**Insert number**>-V, 60-Hz, single-phase, instant-reversing, continuous-duty motor for operating gate arm. Transmit power to gate-arm drive shaft through the speed reducer to harmonic-acting crank and connecting rod. Fabricate crank, rod, and drive shaft of galvanized solid bar steel. Provide an operable cam for adjusting arm travel.

1. Opening Time: [**Three**][**Six**]<**Insert number**> seconds.
2. Inherently adjustable, torque limiting clutch for safety.

I. Characteristics:

1. Audible alarm that activates as part of a safety device system.
2. Additional obstruction detector; noncontact [**infrared**][**photoelectric**][**radio-frequency barrier**].
3. Gate-arm warning safety signs on both sides of unit to limit traffic to vehicular traffic.
4. Low-voltage [**yellow**][**red**] warning lights that illuminate when gate is in down position.
5. Low-voltage light on cabinet top that flashes or changes from red to green when barrier gate is operating.
6. LED integrated into gate-arm for increased visibility.
7. Manually operated crank for emergency operation.
8. Authorities having jurisdiction's emergency access by <**Insert type**>.
9. Gate-arm tip support[**with electromagnetic lock**].
10. Gate-arm skirt bottom[**and top**].

2.4 VEHICLE DETECTORS

A. Vehicle Detectors: Provide detection devices that sense presence or transit of vehicles and emit signals activating gate-arm operators.

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

a. [**Amano Cincinnati, Inc**]

b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Delta Scientific Corporation**]
d. [**Engineered Parking Systems, Inc**]
e. [**Magnetic AutoControl USA**]
f. [**Parking Systems, Inc.**]
g. <**Insert manufacturer's name**>

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

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Delta Scientific Corporation**]
d. [**Engineered Parking Systems, Inc**]
e. [**Magnetic AutoControl USA**]
f. [**Parking Systems, Inc.**]
g. <**Insert manufacturer's name**>

B. Vehicle Loop Detector System: Self-tuning electronic presence detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light. Include automatic closing timer with adjustable time delay before closing[**, timer cut-off switch,**] designed to hold gate arm open until traffic clears. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location indicated on Drawings, as recommended in writing by detection system manufacturer for [**pave-over**][**saw-cut**] installation.

1. Field-Assembled Loop: Wire, in size indicated for field assembly.
2. Factory-Formed Loop: Wire, preformed in size indicated.
3. Operation:

a. Recognize vehicles within **6 inches (152 mm)** of each other on standard-sized loop.
b. Recognize vehicle direction by detecting vehicle moving from one loop to another.
c. Generate reverse count if vehicle backs up after generating directional count in forward direction.
d. Continuous diagnostic monitoring [**and memory**]for intermittently operating and failed loops.
e. Crosstalk test between adjacent loops.

C. Active Infrared Vehicle Detector: [**Retroreflective**][**Emitter/receiver**]-type presence detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of vehicle in gate-arm pathway by interrupting infrared beam in zone pattern and to emit signal activating gate-arm operator. Include automatic closing timer with adjustable time delay before closing[**, timer cut-off switch,**] and vehicle presence detector designed to hold gate arm open until traffic clears.

2.5 TRAFFIC CONTROLLERS

A. Traffic Controllers: Provide directional enforcement system that allows passage of vehicle in only one direction.

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

a. [**Ameristar Perimeter Security; ASSA ABLOY**]

b. [**Delta Scientific Corporation**]
c. [**DoorKing, Inc**]
d. [**Engineered Parking Systems, Inc**]
e. [**Falcon Eye Global Security, LLC**]
f. <**Insert manufacturer's name**>

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

a. [**Ameristar Perimeter Security; ASSA ABLOY**]
b. [**Delta Scientific Corporation**]
c. [**DoorKing, Inc**]
d. [**Engineered Parking Systems, Inc**]
e. [**Falcon Eye Global Security, LLC**]
f. <**Insert manufacturer's name**>

B. Penetrating Type: System consisting of multiple raised teeth that allow vehicular traffic in one direction and that puncture tires of vehicular traffic in the other direction. Fabricate system from steel plate contained in welded steel frame.

1. Mounting: [**Surface**][**Recessed**].
2. Operation: [**Manual, with each tooth controlled by torsion spring**][**Electromechanical**][**Hydraulic**].
3. Latch Down: Allow disarming for two-way traffic flow. Furnish [**one**]<**Insert number**> tool(s) for latch-down operation.
4. Illuminated Warning Signs: [**Single**][**Double**]-faced warning signs consisting of LED lamps [**with photo cell control**]and keyed on/off override switches, contained in welded steel bodies with baked-enamel or powder-coat finish and fiberglass sign faces[**, with flood lamp**].

a. Post Mounting: Provide [**in-ground**][**surface-mounted**] base sleeves and posts.
b. Sign Copy: [**"Wrong Way, Stop, Severe Tire Damage."**][**"Warning, Do Not Back Up, Tire Damage."**]<**Insert message.**>

5. Speed Bumps: [**Composite plastic**][**Compression molded rubber compound**] for speed reduction to **5 mph (8 km/h)** or less.

C. Nonpenetrating Type: System consisting of steel curb that allows traffic in only one direction. Fabricate system from steel plate contained in welded steel frame.

1. Mounting: [**Surface**][**Recessed**].
2. Operation: [**Manual**][**Electromechanical**][**Hydraulic**].

2.6 ENTRY TERMINALS

A. Entry Terminals: Provide entry terminals with mechanisms, components, and controllers housed in cabinet enclosures.

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

a. [**Amano Cincinnati, Inc**]

b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**CAME Americas Automation LLC**]
d. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
e. [**Engineered Parking Systems, Inc**]
f. [**Falcon Eye Global Security, LLC**]
g. [**Parking Systems, Inc.**]
h. [**Zeag; HUB Parking Technology; FAAC Group**]
i. <**Insert manufacturer's name**>

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

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**CAME Americas Automation LLC**]
d. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
e. [**Engineered Parking Systems, Inc**]
f. [**Falcon Eye Global Security, LLC**]
g. [**Parking Systems, Inc.**]
h. [**Zeag; HUB Parking Technology; FAAC Group**]
i. <**Insert manufacturer's name**>

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.
3. Time Indicator: 24-hour cycle with [**A.M. and P.M.**][**military-time**] clock mechanism.
4. Voice annunciation.
5. Tickets: [**Standard paper**][**Magnetic stripe**][**Barcode**].
6. Removable ticket tray with capacity of [**5000**]<**Insert number**> fan-folded tickets.
7. Battery backup for clock and RAM memory.
8. Communication port.
9. Thermostatically controlled heater with on/off/auto switch.
10. Thermostatically controlled fan with on/off/auto switch.
11. Ticket printing and dispensing mechanism.
12. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
13. Access card reader.
14. Multiple ticket option for valet parking.
15. Intercom.
16. Pinhole camera.
17. Barcode imager scanner.
18. Proximity access reader.
19. Automatic vehicle identification reader.
20. License plate recognition.

C. Operational Characteristics:

1. Operation: [**Standalone**][**Online communication to remote computer**].
2. Activation by [**button with "Push for Ticket" message**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**]<**Insert device**>.

a. On activation by button, unit automatically records entry time[**, license plate,**] and date on ticket,[**sounds buzzer,**] dispenses ticket, and raises barrier gate.

b. On activation by means other than button, credentials are recorded and signal is automatically sent to raise barrier gate.

3. Credit card pay on entry.
4. Automatic ticket validation.
5. Programmable ticket numbering.
6. Programmable facility code.
7. Programmable display.
8. Programmable timer for closing barrier gate.
9. Built-in-service diagnostics.
10. Low-ticket alarm.
11. Out-of-ticket alarm.
12. Ticket jam detection.
13. Test ticket printing.
14. Back-out ticket function.
15. Cancel transaction function.

D. Cabinets: Fabricated from sheet metal with seams welded and ground smooth, approximately **15 inches square by 40 inches tall (381 mm square by 1016 mm tall)**; consisting of base and top components. Provide single, gasketed access door for each base component with flush-mounted locks. Furnish [**two**]<**Insert number**> keys for each lock[**, all locks keyed alike**]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet. Fabricate top component so it can be unlocked and opened for ticket loading and maintenance. Include flush-mounted lock in rear of top, keyed the same as base component lock.

1. Steel Sheet: Not less than **0.097-inch- (2.5-mm-)** thick[**, galvanized-**] steel sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**]<**Insert color**> baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch- (3.2-mm-)** thick, aluminum sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**]<**Insert color**> baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch- (2.8-mm-)** thick, stainless-steel sheet.

   a. Finish cabinet exterior with No. 4 finish.

E. Ticket-Dispensing Mechanisms: Removable assembly, with [**self-sharpening ticket cutter**][**or**][**ticket burster**] and plug-in controller.

2.7 EXIT TERMINALS

A. Exit Terminals: Provide exit terminals with controllers and components housed in cabinet enclosures.

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

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**CAME Americas Automation LLC**]

d. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
e. [**Engineered Parking Systems, Inc**]
f. [**Parking Systems, Inc.**]
g. [**Zeag; HUB Parking Technology; FAAC Group**]
h. <**Insert manufacturer's name**>

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

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**CAME Americas Automation LLC**]
d. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
e. [**Engineered Parking Systems, Inc**]
f. [**Parking Systems, Inc.**]
g. [**Zeag; HUB Parking Technology; FAAC Group**]
h. <**Insert manufacturer's name**>

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.
3. Voice annunciation.
4. Battery backup for clock and RAM memory.
5. Communication port.
6. Thermostatically controlled heater with on/off/auto switch.
7. Thermostatically controlled fan with on/off/auto switch.
8. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
9. Access card reader.
10. Ticket reader.
11. Receipt printer.
12. Intercom.
13. Pinhole camera.
14. Barcode imager scanner.
15. Proximity access reader.
16. Automatic vehicle identification reader.
17. License plate recognition.

C. Operational Characteristics:

1. [**Standalone**][**Online communication to remote computer**].
2. Activation by [**ticket insertion**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**]<**Insert device**>.
3. Activation results in the following:

a. Valid Prepaid Exit: Signal is automatically sent to raise barrier gate.
b. Pay at Exit: Parking fee is calculated and displayed for payment.
c. Invalid Exit: Activation is rejected and "Pay Cashier First" or "Return to Cashier" message is displayed.

4. Programmable lost ticket function.
5. Display fee.
6. Accept payment by [**credit card**][**debit card**][**smart card**][**prepaid value card**][**scanned**

media][**and**][**merchant ticket**].
7. Accept discounted coupons.
8. Print receipts on demand.
9. Programmable facility code.
10. Programmable grace period.
11. Programmable display.
12. Programmable timer for closing barrier gate.
13. Reports for events and exception events.
14. Programmable merchant validations.
15. Built-in service diagnostics.
16. Cancel transaction function.

D. Cabinets: Fabricated from sheet metal with seams welded and ground smooth; approximately **15 inches square by 40 inches tall (381 mm square by 1016 mm tall)**. Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish [**two**]<**Insert number**> keys for each lock[**, all locks keyed alike**]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

1. Steel Sheet: Not less than **0.097-inch- (2.5-mm-)** thick[**, galvanized-**] steel sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**]<**Insert color**> baked-enamel or powder-coat finish.

2. Aluminum Sheet: Not less than **0.125-inch- (3.2-mm-)** thick, aluminum sheet.

   a. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**]<**Insert color**> baked-enamel or powder-coat finish.

3. Stainless-Steel Sheet: Not less than **0.109-inch- (2.8-mm-)** thick, stainless-steel sheet.

   a. Finish cabinet exterior with No. 4 finish.

2.8 PAY STATIONS

A. Pay Stations: Provide self-contained, cashiering [**central**][**entry**][**exit**] pay stations designed for self-service operation; with mechanisms, components,[**controllers,**] and fee computers housed in a combined enclosure.

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

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   d. [**Engineered Parking Systems, Inc**]
   e. [**Parking Systems, Inc.**]
   f. [**Zeag; HUB Parking Technology; FAAC Group**]
   g. <**Insert manufacturer's name**>

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

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
d. [**Engineered Parking Systems, Inc**]
e. [**Parking Systems, Inc.**]
f. [**Zeag; HUB Parking Technology; FAAC Group**]
g. <**Insert manufacturer's name**>

B. Physical Characteristics:

1. Digital display, touchscreen, or LCD.
2. Time and date display.
3. Voice annunciation.
4. Battery backup for clock and RAM memory.
5. Thermostatically controlled heater with on/off/auto switch.
6. Thermostatically controlled fan with on/off/auto switch.
7. Ticket printing and dispensing mechanism.
8. Credit card activation slot, credit card reader[**with smart card reader**], and "Insert Ticket/Card" message.
9. Bill acceptor.
10. Access card reader.
11. Ticket reader.
12. Printer.
13. Intercom.
14. Pinhole camera.
15. Barcode imager scanner.
16. Proximity access reader.
17. Automatic vehicle identification reader.
18. License plate recognition.

C. Operational Characteristics:

1. [**Standalone**][**Online communication to remote computer**].
2. Activation by [**ticket insertion**][**vehicle detector**][**credit card in/out**][**license plate recognition**][**automatic vehicle identification**][**proximity**][**scanned electronic or hardcopy media**][**access card**]<**Insert device**>.
3. Activation results in the following:

    a. Valid Prepayment: Signal is automatically sent to raise barrier gate.
    b. Payment Prompt: Parking fee is calculated and displayed for payment.

4. Compute multiple parking fees based on recorded entry times.
5. Compute multiple taxes by percentage and fixed amount.
6. Programmable lost ticket function.
7. Display fee.
8. Accept payment by cash and [**credit card**][**debit card**][**scanned media**][**smart card**][**prepaid value card**][**and**][**merchant ticket**].
9. Accept discounted coupons.
10. Compute change.
11. Print receipts on demand.
12. Print validation on ticket.
13. Print audit trail.
14. Programmable for up to [**six**]<**Insert number**> fee structures.
15. Test mode to verify accuracy of fee structure program.
16. Programmable time.
17. Programmable facility code.

18. Programmable grace period.
19. Programmable display.
20. Programmable timer for closing barrier gate.
21. Programmable merchant validations.
22. Built-in service diagnostics.
23. Print cash audit, revenue, operational, and statistical reports on demand.
24. Duress alarm output for emergencies.
25. Cancel transaction function.

D. Cabinets: Fabricated from cold-rolled steel sheet with seams welded and ground smooth, approximately **36 inches wide by 18 inches deep by 60 inches tall (914 mm wide by 457 mm deep by 1524 mm tall)**. Provide single, gasketed access door with flush-mounted locks. Furnish [**two**]<**Insert number**> keys for each lock[**, all locks keyed alike**]. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.

1. Finish cabinet, interior and exterior, with manufacturer's standard [**white**][**yellow**]<**Insert color**> baked-enamel or powder-coat finish.

2.9 FEE COMPUTERS

A. Fee Computers: Provide modular[**PC-based**] system. Register permanent record of each transaction in computer's memory.

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

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   d. [**Engineered Parking Systems, Inc**]
   e. [**Falcon Eye Global Security, LLC**]
   f. [**Parking Systems, Inc.**]
   g. [**Zeag; HUB Parking Technology; FAAC Group**]
   h. <**Insert manufacturer's name**>

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

   a. [**Amano Cincinnati, Inc**]
   b. [**ASPS Access Security & Parking Systems Inc.**]
   c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
   d. [**Engineered Parking Systems, Inc**]
   e. [**Falcon Eye Global Security, LLC**]
   f. [**Parking Systems, Inc.**]
   g. [**Zeag; HUB Parking Technology; FAAC Group**]
   h. <**Insert manufacturer's name**>

B. Physical Characteristics:

1. Touchscreen display.
2. Battery backup for clock and RAM memory.

3. Communication port.
4. [**Cash drawer**][**Two cash drawers**].
5. Standard ticket reader.
6. Magnetic stripe ticket reader.
7. Barcode ticket reader.
8. Credit card reader[**with smart card reader**].
9. Access card reader.
10. Proximity access reader.
11. Automatic Vehicle Identification reader.
12. License plate recognition.
13. [**Keyed**][**Keyless-membrane**] keypad.
14. Detachable printer.

C. Operational Characteristics:

1. Compute multiple parking fees based on entry times on ticket from ticket dispenser.
2. Compute multiple taxes by percentage and fixed amount.
3. Programmable lost ticket function.
4. Display fee on remote fee display device.
5. Credit card in/out.
6. Accept payment by cash and [**credit card**][**debit card**][**smart card**][**prepaid value card**][**and**][**merchant ticket**].
7. Accept discounted coupons.
8. Control independent cash drawer.
9. Compute change.
10. Print receipts.
11. Print validation on ticket.
12. Print audit trail.
13. Reload value cards.
14. Interface to automatic barrier gate.
15. Programmable with up to [**six**]<**Insert number**> fee structures.
16. Programmable time.
17. Programmable keys.
18. Programmable for special events validations.
19. Programmable for automatic activation for limited date and time validations.
20. Programmable merchant validations.
21. Programmable valet parking.
22. Programmable hotel guest parking.
23. Three levels of security including cashier, supervisor, and master.
24. Recall last transaction.
25. Test mode to verify accuracy of fee structure program.
26. Built-in service diagnostics.
27. View cash audit, revenue, operational, and statistical reports on screen or print on demand.
28. Duress alarm output for emergencies.

D. Cash Drawer: Fabricated with a removable tray and drawer, with five compartments for paper currency and five compartments for coins.

E. Remote Fee Display: Single-faced signs designed for use with fee computer, consisting of **1-inch- (25-mm-)** tall, digital displays or LCDs contained in welded steel bodies with baked-enamel or powder-coat finish.

1. Messages: Amount due, "Thank You," "Closed," and time in A.M./P.M. format.
2. Mounting: [**Front of cashier's booth**][**42-inch- (1067-mm-) high pedestal**].

2.10 MISCELLANEOUS PARKING CONTROL EQUIPMENT

A. "Lot Full" Signs : Single-faced signs consisting of illumination source contained in welded steel bodies with extended hood and baked-enamel finish. Sign copy shall be [**4 (102)**]<**Insert dimension**> **inches (mm)** tall.

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

    a. [**ASPS Access Security & Parking Systems Inc.**]
    b. [**CAME Americas Automation LLC**]
    c. [**Engineered Parking Systems, Inc**]
    d. <**Insert manufacturer's name**>

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

    a. [**ASPS Access Security & Parking Systems Inc.**]
    b. [**CAME Americas Automation LLC**]
    c. [**Engineered Parking Systems, Inc**]
    d. <**Insert manufacturer's name**>

3. Type: [**Flashing**][**Nonflashing**].
4. Operation: [**Manual by push button**][**Automatic by barrier gate controller**].
5. Illumination: [**Traffic signal lamps and colored**][**LED bulb and clear**] acrylic sign face.
6. Mounting: [**Top of barrier gate cabinet**][**42-inch- (1067-mm-) high pedestal**].

2.11 PARKING FACILITY MANAGEMENT SOFTWARE

A. Parking Facility Management Software: Manufacturer's standard software that is compatible with security-access control system and that provides automatic facility monitoring, supervision, and remote control of parking control equipment from one or more locations.

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

    a. [**Amano Cincinnati, Inc**]
    b. [**ASPS Access Security & Parking Systems Inc.**]
    c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
    d. [**WPS Parking Systems; Dynniq Group**]
    e. <**Insert manufacturer's name**>

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

    a. [**Amano Cincinnati, Inc**]
    b. [**ASPS Access Security & Parking Systems Inc.**]
    c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]

d. [**WPS Parking Systems; Dynniq Group**]
e. <**Insert manufacturer's name**>

B. Operation:

1. Collect data for revenue and activity reporting.
2. Collect data for access and space control.
3. Notification services.
4. On-line prepaid parking.
5. Event management.
6. Validation solutions.
7. License plate recognition systems.
8. Pay-by-phone.
9. Loyalty programs.
10. Track tickets.
11. Programmable parking control equipment.

2.12 ACCESS CONTROL UNITS

A. Access Control Units: Provide access control unit that activates barrier gates.

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

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
d. [**DoorKing, Inc**]
e. [**Engineered Parking Systems, Inc**]
f. [**Falcon Eye Global Security, LLC**]
g. [**Nortek Security & Control, LLC**]
h. [**Parking Systems, Inc.**]
i. <**Insert manufacturer's name**>

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

a. [**Amano Cincinnati, Inc**]
b. [**ASPS Access Security & Parking Systems Inc.**]
c. [**Canadian Parking Equipment Ltd./American Parking Equipment Inc.**]
d. [**DoorKing, Inc**]
e. [**Engineered Parking Systems, Inc**]
f. [**Falcon Eye Global Security, LLC**]
g. [**Nortek Security & Control, LLC**]
h. [**Parking Systems, Inc.**]
i. <**Insert manufacturer's name**>

B. Unit Housing: Fabricate from [**welded cold-rolled steel or aluminum sheet**][**plastic**] with weatherproof front access panel equipped with flush-mounted lock and [**two**]<**Insert number**> keys. Provide face-lighted unit fully visible at night.

1. Steel Finish: Manufacturer's standard baked-enamel or powder-coat finish system.

C. Card Reader Controlled Unit: Functions only when authorized card is presented.

1. System: [**Magnetically coded, single-code system activated by coded card**][**Programmable, multiple-code capability permitting validation or voiding of individual cards**].

    a. Permit four different access time periods.

2. Reader Type: [**Swipe**][**Insertion**][**Proximity**].

    a. Swipe reader for [**magnetic-stripe**][**barcode**][**Wiegand**] cards.
    b. Insertion reader for [**magnetic-stripe**][**barcode**][**Wiegand**] cards.
    c. Proximity reader for proximity cards.

3. Operation: [**Standalone**][**Online communication to remote parking control system computer**][**Online communication to remote security-access control system computer**].
4. Characteristics: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing barrier gate activity**][**Digital display or LCD**][**Programmable by PDA (personal digital assistant) by infrared interface**]<**Insert feature**>.
5. Mounting: [**With pedestal**][**Wall**][**In enclosed cabinet**][**As indicated on Drawings**]<**Insert mounting**>.
6. Cards: Provide <**Insert number**>.

    a. Imprint cards with <**Insert special printing requirements such as company logo or emblem**>.

D. Digital Keypad Controlled Unit: Functions only when authorized code is entered on [**keyed**][**keyless-membrane**] keypad.

1. System: [**Multiple-code capability**][**Programmable, multiple-code capability**].

    a. Multiple-code capability of no fewer than [**five**][**100**][**500**]<**Insert number**> possible individual codes.
    b. Programmable, multiple-code capability permitting validation or voiding of no fewer than [**100**][**2500**][**10,000**]<**Insert number**> possible individual codes, consisting of [**one to six**]<**Insert number**> digits[**, and permitting four different access time periods**].

2. Operation: [**Standalone**][**Online communication to remote parking control system computer**][**Online communication to remote security-access control system computer**].
3. Characteristics: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing barrier gate activity**]<**Insert feature**>.
4. Mounting: [**With pedestal**][**Wall**][**As indicated on Drawings**]<**Insert mounting**>.

E. Radio-Controlled System: Digital access control system consisting of code-compatible universal coaxial receiver[**, one per barrier gate**][**, where indicated on Drawings**], remote antenna with coaxial cable and mounting brackets, and [**one permanently mounted**][**four portable**]<**Insert number and use condition**> transmitter(s) per receiver designed to operate barrier gates. Provide programmable transmitter with multiple-code capability permitting validation or voiding of no fewer than [**1000**][**10,000**]<**Insert number**> codes per channel configured for the following functions:

1. Transmitters: [**Single-button**][**Triple-button**] operated.

    a. Single-button operated with [**open**][**open and close**] functions.
    b. Triple-button operated with open, close, and stop functions.

        1) Provide transmitters featuring [**two**][**three**][**four**]<**Insert number**> independent

channel settings controlling separate receivers for operating more than one barrier gate from each transmitter.

2.13 ANCHORAGES

A. Anchor Bolts: [**Galvanized**][**Stainless steel**].

1. Hot-dip galvanized according to ASTM A153/A153M and ASTM F2329/F2329M.
2. Stainless steel, [**Type 304**][**Type 316**][**Type 304 or 316 as indicated**]<**Insert type**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including equipment bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before parking control equipment installation.

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

3.2 PREPARATION

A. Excavation for Traffic Controllers: Saw cut existing pavement for recessed traffic controllers and hand-excavate recesses to dimensions and depths and at locations as required by traffic controller manufacturer's written instructions and as indicated on Drawings.

3.3 INSTALLATION, GENERAL

A. Install parking control equipment as required for complete and integrated installation.

1. Rough-in electrical connections.

3.4 INSTALLATION OF AUTOMATIC BARRIER GATES

A. Anchor cabinets to concrete bases with anchor bolts or expansion anchors, and mount barrier gate arms.

1. Install barrier gates according to UL 325.

3.5 INSTALLATION OF VEHICLE DETECTORS

A. [**Cut grooves in pavement and bury**][**Bury**] and seal wire loop at locations indicated on Drawings according to manufacturer's written instructions. Connect to parking control equipment operated by detector.

3.6 INSTALLATION OF TRAFFIC CONTROLLERS

A. Anchor controllers to [**recessed concrete bases**][**driveway surfaces**] with anchor bolts or expansion anchors.

3.7 INSTALLATION OF ENTRY TERMINALS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.8 INSTALLATION OF EXIT TERMINALS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.9 INSTALLATION OF PAY STATIONS

A. Attach cabinets to concrete bases with anchor bolts or expansion anchors.

1. Connect equipment to remote computer.
2. Load ticket dispenser with supply of tickets.

3.10 INSTALLATION OF FEE COMPUTERS

A. Install computers at locations indicated, including connecting to peripheral equipment[**and remote computers**].

3.11 INSTALLATION OF CARD READER PEDESTALS

A. [**Pad**][**In-ground**] mount with mounting bolts.

3.12 INSTALLATION OF ELECTRICAL

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect

components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Parking control equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.14 ADJUSTING

A. Adjust parking control equipment to function smoothly, and lubricate as recommended by manufacturer.

B. Confirm that locks engage accurately and securely without forcing or binding.

C. After completing installation of exposed, factory-finished parking control equipment, inspect exposed finishes and repair damaged finishes.

3.15 PROTECTION

A. Remove barrier gate arms during the construction period to prevent damage, and install them immediately before Substantial Completion.

3.16 MAINTENANCE SERVICE

A. Maintenance Service Description: Beginning at Substantial Completion, maintenance service shall include [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of parking control equipment Installer**][**manufacturer's authorized service representative**]. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper parking control equipment operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.17 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [**two**]<**Insert number**> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.18 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain parking control equipment.

3.19 PARKING CONTROL EQUIPMENT SCHEDULE

A. Provide parking control equipment for each lane as follows:

1. Lane <**Insert designation**>: <**Insert list of equipment**>.

END OF SECTION 01 55 26 00

SECTION 01 55 26 00A - FABRICATED CONTROL BOOTHS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fabricated steel control booths.
2. Fabricated aluminum control booths.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Fabricated steel control booths.
2. Fabricated aluminum control booths.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control booths.
2. Include rated capacities, operating characteristics, and electrical characteristics, for included systems.

C. Shop Drawings: For control booths. Include plans, elevations, sections, details, accessories, and fastening and anchorage details, including mechanical fasteners.

1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates. Include location, diameter, and projection of anchor bolts required to attach control booths to foundation. Indicate post reactions at each location.

D. Samples: For each exposed product and for each color and texture specified, approximately **8-1/2 by 11 inches (215 by 280 mm)** in size.

E. Samples for Initial Selection: For each type of exposed finish.

F. Samples for Verification: For each type of exposed finish in manufacturer's standard sizes.

1. Include Samples of wall panels and accessories to verify finish selection.

G. Delegated Design Submittals: For fabricated control booths, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For control booths to include in maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair finish or replace control booths that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fabricated control booths.

B. Structural Performance: Fabricated control booths to withstand the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]<**Insert requirement**>:

1. Loads: [**As indicated on Drawings**]<**Insert loads**>.

C. Seismic Performance: Fabricated control booths to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. Loads: [**As indicated on Drawings**]<**Insert loads**>.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**]<**Insert temperature range**>.

E. Ballistic Resistance: Provide components, including windows, walls, and doors, identical to those tested for compliance with requirements indicated, and as follows:

1. UL Rating: [**Listed and labeled as**][**Level 1**][**Level 2**][**Level 3**][**Level 4**][**Level 5**][**Level 6**][**Level 7**][**Level 8**]<**Insert Level**> when tested in accordance with UL 752.
2. NIJ Classification: [**Type I**][**Type IIA**][**Type II**][**Type IIIA**][**Type III**][**Type IV**] when tested in accordance with NIJ STD-0108.01.

F. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and marked for intended location and application.

G. Safety Glazing: Comply with 16 CFR 1201, Category II.

1. Safety Glazing Labeling: Permanently mark glazing with certification label of [**the SGCC**][**the SGCC or another certification agency acceptable to authorities having jurisdiction**][**or**][**manufacturer**], indicating manufacturer's name, glass type, thickness, and safety glazing standard with which glass complies.

H. Regulatory Requirements: Comply with applicable provisions in [**the U.S. Department of Justice's "2010 ADA Standards for Accessible Design"**][**and**][**ICC A117.1**].

2.2 FABRICATED STEEL CONTROL BOOTHS

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

1. [**Austin Mohawk and Company, Inc.**]
2. [**B.I.G. Enterprises, Inc**]
3. [**Delta Scientific Corporation**]
4. [**Keystone Structures, Inc.**]
5. [**Little Buildings, Inc.**]
6. [**Panel Built, Inc.**]
7. [**Par-Kut International, Inc**]
8. [**Porta-King Building Systems; a division of Jay Henges Enterprises, Inc.**]
9. [**United Partition Systems, Inc.**]
10. <**Insert manufacturer's name**>

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

1. [**Austin Mohawk and Company, Inc.**]
2. [**B.I.G. Enterprises, Inc**]
3. [**Delta Scientific Corporation**]
4. [**Keystone Structures, Inc.**]
5. [**Little Buildings, Inc.**]
6. [**Panel Built, Inc.**]
7. [**Par-Kut International, Inc**]
8. [**Porta-King Building Systems; a division of Jay Henges Enterprises, Inc.**]
9. [**United Partition Systems, Inc.**]
10. <**Insert manufacturer's name**>

C. Building Style: [**Standard square corners**][**Radius corners**][**Round corners**][**Butt-glazed corners**][**Wraparound type, with single rounded building end**][**Wraparound type, with both building ends rounded**][**As indicated on Drawings**].

D. Structural Framework: Fabricated from **2-by-2-by-0.075-inch (51-by-51-by-1.90-mm)** steel structural or mechanical tubing. Connect framework by welding.

E. Sliding Doors: Top suspended from aluminum track with ball-bearing rollers; **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from [**clear-anodized aluminum**][**galvanized steel**]; with [**top half**][**full height**] of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping. Provide door on [**one side**][**both sides**] of booth.

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**]<**Insert glazing**> glass.
2. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.

F. Swinging Doors: **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from [**clear-anodized aluminum**][**galvanized steel**]; with [**top half**][**full height**] of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.[**Provide door on back of booth.**]

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**]<**Insert glazing**> glass.

2. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.

G. Windows: Extruded-aluminum sash frames glazed with clear [**tempered**][**insulating**]<**Insert glazing**> glass.

1. Frame Finish: Manufacturer's standard mill or clear anodic.
2. Operable Windows: Equip windows with cam locks, weather stripping, and [**stainless steel**][**nylon**] ball-bearing rollers.
3. Screens: [**Insect**][**Security**] screens for each window.
4. Corner Shape: [**Square**][**Round**].

H. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from **0.079-inch (2.01-mm)** nominal-thickness, galvanized-steel sheet; and interior face panel fabricated from [**0.064-inch (1.63-mm)**][**0.052-inch (1.32-mm)**] nominal-thickness, galvanized-steel sheet; with [**2-inch- (51-mm-)**][**3-inch- (76-mm-)**]<**Insert dimension**> thick, [**rigid fiberglass**][**or**][**polystyrene board**] insulation in cavity between exterior and interior face panels.

I. Raised Base Assembly: [**4-inch- (102-mm-)**][**3-inch- (76-mm-)**] high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from **2-by-4-inch (51-by-102-mm)** galvanized-steel structural tubing; **0.108-inch (2.74-mm)** nominal-thickness, C-shaped, galvanized-steel sheet channels; or galvanized structural-steel angles. Include anchor clips fabricated from **1/4-inch- (6-mm-)** thick galvanized-steel plate, predrilled and welded to exterior of integral floor frame.

1. Tread Plate Floor Assembly: **0.108-inch (2.74-mm)** nominal-thickness, galvanized, rolled steel tread plate.
2. Insulated Floor Assembly: Assembly consisting of **0.079-inch (2.01-mm)** nominal-thickness, galvanized-steel sheet underside with rigid insulation core; covered by **0.125-inch- (3.18-mm-)** thick, aluminum rolled tread plate; with overall assembly thickness of **2 inches (51 mm)**.
3. Uninsulated Floor Assembly: Assembly consisting of [**one**][**two**] layer(s) of **3/4-inch- (19-mm-)** thick plywood or oriented strand board with [**0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate**][**vinyl composition flooring**][**carpeting**].

J. Flush Base Assembly: No perimeter frame, with finished floor fabricated from **0.108-inch (2.74-mm)** nominal-thickness, galvanized, rolled steel tread plate.

K. Open Base: No perimeter frame, with surface of supporting concrete base as finished floor.

L. Flat Roof/Ceiling Assembly: Assembly consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.

1. Exterior Roof Panel: Fabricated from [**0.079-inch (2.01-mm)**][**0.064-inch (1.63-mm)**] nominal-thickness, galvanized-steel sheet; with [**painted finish**][**EPDM membrane**], continuously welded seams[**, and full-perimeter gutter**].
2. Interior Ceiling Panel: Fabricated from **0.079-inch (2.01-mm)** nominal-thickness, galvanized-steel sheet; with fiberglass insulation in cavity between ceiling and roof.
3. Insulated Composite Panel: Fabricated from **0.028-inch (0.71-mm)** nominal-thickness, galvanized-steel sheet faces and expanded-foam insulation core.
4. Canopy Fascia: Fabricated from **0.079-inch (2.01-mm)** nominal-thickness, galvanized-steel sheet, of [**manufacturer's standard design**][**custom design indicated on Drawings**].

a. Height: [**6 inches (152 mm)**][**8 inches (203 mm)**]<**Insert dimension**>.
b. Configuration:

1) Overhang [**3 inches (76 mm)**]<**Insert dimension**> beyond face of walls below.
2) Flush with face of walls below.

5. Downspouts: Integral, extending **3 inches (76 mm)** beyond booth walls.
6. Roof scuppers.
7. Rooftop finial.

M. Work Counters: Full width of control booth, reinforced; with **16-inch- (406-mm-)** wide [**storage**][**cash**] drawer below each counter and an access opening for electrical cords at[**each**] rear corner of counter.

1. Material: [**0.078-inch- (1.98-mm-) thick, stainless steel sheet**][**0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet**][**1/2-inch- (13-mm-) thick particleboard with plastic-laminate finish**].
2. Depth: [**18 inches (457 mm)**][**20 inches (508 mm)**][**22 inches (559 mm)**]<**Insert dimension**>.

N. Electrical:

1. Single-Point Connection: Service-entrance-rated, fused safety switch located on exterior for connection of 125 A, [**120/240 V, single-phase, three-wire**][**120/208 V, single-phase, three-wire**][**208Y/120 V, three-phase, four-wire**] feeder with equipment ground conductor.
2. Grounding: Grounding electrode bonded to equipment ground conductor at single-point connection in accordance with NFPA 70 and Section 260526 "Grounding and Bonding for Electrical Systems."
3. Power Distribution: Readily accessible panelboard in accordance with Section 262416 "Panelboards" installed at [**interior**][**exterior**] location[**coordinated with Architect**]. Include 25 percent provisions for installation of additional future devices.
4. Power Connections:

    a. [**One**]<**Insert number**> duplex, weatherproof, ground-fault circuit interrupter (GFCI), NEMA 5-15R power outlet(s) for servicing exterior equipment.
    b. [**One**][**Two**]<**Insert number**> duplex, [**ground-fault circuit interrupter (GFCI),**] NEMA 5-15R power outlet(s) under counter(s) near access openings.
    c. [**One**][**Two**]<**Insert number**> Type USB-A power outlet(s) above counter(s) for charging portable devices.
    d. Provide power connections and means of disconnect for interior and exterior HVAC equipment.
    e. Provide power connections and means of disconnect for vehicle[**and pedestrian**] control equipment.

5. Lighting:

    a. Booth Interior: LED. Provide **20-fc (200-lux)** average horizontal illuminance, with uniformity not exceeding 2:1 average-to-minimum[**, dimmable from 100 percent to 10 percent,**] on counter work surfaces.
    b. Booth Exterior: LED, located above door. Provide not less than **0.5-fc (5-lux)** average horizontal illuminance, with uniformity not exceeding 3:1 maximum-to-minimum, when measured at finished grade over the distance of **15 ft. (4.5 m)** from entrance door.
    c. Vehicle and Pedestrian Circulation:

        1) LZ1: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **2-fc (20-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1.5-fc (15-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
        2) LZ2: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1.5-fc (15-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1-fc (10-lux)** average vertical illuminance when measured

3 to 5 ft. (1 to 1.5 m) above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.

3) LZ3: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance 10 ft. (3 m) from booth, provide not less than 1-fc (10-lux) average horizontal illuminance when measured 4 ft. (1.2 m) above finished grade and not less than 0.8-fc (8-lux) average vertical illuminance when measured 3 to 5 ft. (1 to 1.5 m) above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.

4) LZ4: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance 10 ft. (3 m) from booth, provide not less than 0.8-fc (8-lux) average horizontal illuminance when measured 4 ft. (1.2 m) above finished grade and not less than 0.6-fc (6-lux) average vertical illuminance when measured 3 to 5 ft. (1 to 1.5 m) above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.

d. Controls: [**Provide manual switches for interior and exterior lighting on wall inside booth door**][**Provide automatic photocontrol for interior and exterior lighting, with manual override located on wall inside booth door**].

O. Communications:

1. [**One**]<**Insert number**> communications outlet(s) under counter(s) with [**two**][**four**]<**Insert number**> TIA-1096-A miniature eight-position series jack(s) for connecting telephone and data equipment.

P. Heating Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled, [**110-V**][**230/208-V**], electric heater with fan-forced operation and with capacity of not less than [5000 Btu/h (1470 W)][7500 Btu/h (2200 W)]<**Insert capacity**>. Enclose in enameled-steel cabinet[**and mount under work counter**].

Q. Cooling Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled air conditioner with cooling capacity of not less than [10,000 Btu/h (2930 W)][12,000 Btu/h (3520 W)][13,500 Btu/h (3960 W)]<**Insert capacity**>. Enclose in enameled-steel cabinet.

R. Accessories: Provide the following for each control booth:

1. Through-wall transaction drawers[**and speaking apertures**].
2. Antifatigue mats.
3. Exterior stainless steel counter.
4. [**Floor**][**Wall-mounted**] safe.
5. Signage: <**Insert requirements**>.
6. Ventilation fan.
7. Insect screens on operable openings.
8. Rollup shutters on doors and windows.
9. Intercom.
10. Traffic control lights.
11. Bollards.

S. Anchorage: [**Cast-in-place anchor bolts**][**Postinstalled anchors**] fabricated from non-ferrous or corrosion-resistant materials, with allowable load or strength design greater than or equal to the design load, as determined by testing conducted by a qualified testing agency.

T. Materials:

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, commercial quality, G90 (Z275) coating designation; mill phosphatized.

2. Galvanized Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D); hot-dip galvanized in accordance with ASTM A123/A123M.
3. Steel Structural Tubing: ASTM A500/A500M, Grade B.
4. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
5. Steel Mechanical Tubing: ASTM A513/A513M, welded-steel mechanical tubing.
6. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized in accordance with ASTM A123/A123M.
7. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

    a. Sheet: ASTM B209/B209M.
    b. Extruded Shapes: **ASTM B221 (ASTM B221M)**.
    c. Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T4 or Alloy 6061-T6.

8. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
9. Plastic Laminate: ISO 4586-3, Grade HGS or HGL.
10. Plywood: DOC PS 1, Exterior grade.
11. Particleboard: ANSI A208.1, Grade M-2.
12. Clear Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, and Quality q3; [**6 mm thick**]<**Insert thickness**>.
13. Clear Insulating Glass: ASTM E2190. Factory-assembled units consisting of two lites of 2.5-mm-thick clear float glass, ASTM C1036, Type I, Class 1, Quality q3, and dehydrated air space, with a total overall unit thickness of [**1 inch (25 mm)**][**3/4 inch (19 mm)**][**5/8 inch (16 mm)**]<**Insert dimension**> and with manufacturer's standard dual seal. Provide tempered lites where indicated.
14. Ballistic-Resistant Glazing: Tested to comply with bullet-resistant testing level indicated.

U. Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply with coating manufacturer's written instructions for applying and baking.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and gloss**>.

2.3 FABRICATED ALUMINUM CONTROL BOOTHS

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

1. [**Allied Modular Building Systems, Inc.**]
2. [**Austin Mohawk and Company, Inc.**]
3. [**Keystone Structures, Inc.**]
4. [**Mardan Fabrication, Inc.**]
5. [**NRB Modular Solutions Inc.**]
6. [**Porta-King Building Systems; a division of Jay Henges Enterprises, Inc.**]
7. [**Portafab Corporation**]
8. [**Starrco**]
9. <**Insert manufacturer's name**>

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

1. [**Allied Modular Building Systems, Inc.**]
2. [**Austin Mohawk and Company, Inc.**]
3. [**Keystone Structures, Inc.**]

4. [**Mardan Fabrication, Inc.**]
5. [**NRB Modular Solutions Inc.**]
6. [**Porta-King Building Systems; a division of Jay Henges Enterprises, Inc.**]
7. [**Portafab Corporation**]
8. [**Starrco**]
9. <**Insert manufacturer's name**>

C. Building Style: [**Standard square corners**][**Radius corners**][**Round corners**][**Butt-glazed corners**][**Wraparound type, with single rounded building end**][**Wraparound type, with both building ends rounded**][**As indicated on Drawings**].

D. Structural Framework: Fabricated from **2-by-2-by-0.125-inch (51-by-51-by-3.18-mm)** aluminum tubing, channel, angle, or tee extrusions; with [**clear**][**color**] anodic finish. Connect framework with[**exposed**] mechanical fasteners.

E. Sliding Doors: Top suspended from aluminum track with ball-bearing rollers; **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from clear-anodized aluminum; with [**top half**][**full height**] of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping. Provide door on [**one side**][**both sides**] of booth.

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**]<**Insert glazing**> glass.
2. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.

F. Swinging Doors: **1-3/4 inches (44 mm)** thick; tubular-frame design fabricated from clear-anodized aluminum; with [**top half**][**full height**] of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.[**Provide door on back of booth.**]

1. Glazing: [**Fixed**][**Horizontal sliding**] unit with clear [**insulating**]<**Insert glazing**> glass.
2. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.

G. Windows: Extruded-aluminum sash frames glazed with clear [**tempered**][**insulating**]<**Insert glazing**> glass.

1. Frame Finish: Manufacturer's standard mill or clear anodic.
2. Operable Windows: Equip windows with cam locks, weather stripping, and [**stainless steel**][**nylon**] ball-bearing rollers.
3. Screens: [**Insect**][**Security**] screens for each window.
4. Corner Shape: [**Square**][**Round**].

H. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from [**0.032-inch- (0.81-mm-)**][**0.063-inch- (1.60-mm-)**] thick aluminum sheet, and interior face panel fabricated from [**0.032-inch- (0.81-mm-)**][**0.050-inch- (1.27-mm-)**] thick aluminum sheet; with **2-inch- (51-mm-)** thick [**polystyrene**][**or**][**polyisocyanurate board insulation**] in cavity between exterior and interior face panels.

I. Raised Base Assembly: **4-inch- (102-mm-)** high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from **2-by-4-by-0.125-inch (51-by-102-by-3.18-mm)** aluminum tubing or aluminum angles. Include anchor clips fabricated from **1/4-inch- (6-mm-)** thick aluminum, predrilled and welded to exterior of integral floor frame.

1. Insulated Floor Assembly: Assembly consisting of **0.032-inch- (0.81-mm-)** thick, aluminum sheet underside with plywood and rigid insulation core; covered by **0.125-inch- (3.18-mm-)** thick, aluminum rolled tread plate; with overall assembly thickness of **2 inches (51 mm)**.
2. Uninsulated Floor Assembly: Assembly consisting of [**one**][**two**] layer(s) of **3/4-inch- (19-mm-)**

thick plywood or oriented strand board with [**0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate**][**vinyl composition flooring**][**carpeting**].

J. Open Base: No perimeter frame, with surface of supporting concrete base as finished floor.

K. Flat Roof/Ceiling Assembly: Assembly consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.

1. Exterior Roof Panel: Fabricated from **0.032-inch- (0.81-mm-)** thick aluminum sheet; with protective plastic sheet finish and full-perimeter gutter.
2. Interior Ceiling Panel: Fabricated from **0.125-inch- (3.18-mm-)** thick hardboard; with polyisocyanurate board insulation in cavity between ceiling and roof.
3. Insulated Composite Panel: Fabricated from **0.032-inch- (0.81-mm-)** thick aluminum sheet faces and expanded-foam insulation core.
4. Canopy Fascia: Fabricated from **0.063-inch- (1.60-mm-)** thick aluminum sheet, of [**manufacturer's standard design**][**custom design indicated on Drawings**].

    a. Height: [**6 inches (152 mm)**][**8 inches (203 mm)**]<**Insert dimension**>.
    b. Configuration:

        1) Overhang [**3 inches (76 mm)**]<**Insert dimension**> beyond face of walls below.
        2) Flush with face of walls below.

5. Downspouts: Integral, extending **3 inches (76 mm)** beyond booth walls.
6. Roof scuppers.
7. Rooftop finial.

L. Work Counters: Full width of control booth, reinforced; with **16-inch- (406-mm-)** wide [**storage**][**cash**] drawer below each counter and an access opening for electrical cords at[**each**] rear corner of counter.

1. Material: **1/2-inch- (13-mm-)** thick particleboard with plastic-laminate finish.
2. Depth: [**18 inches (457 mm)**][**20 inches (508 mm)**][**22 inches (559 mm)**]<**Insert dimension**>.

M. Electrical Power Service:

1. Single-Point Connection: Service-entrance-rated, fused safety switch located on exterior for connection of 125 A, [**120/240 V, single-phase, three-wire**][**120/208 V, single-phase, three-wire**][**208Y/120 V, three-phase, four-wire**] feeder with equipment ground conductor.
2. Grounding: Grounding electrode bonded to equipment ground conductor at single-point connection in accordance with NFPA 70 and Section 260526 "Grounding and Bonding for Electrical Systems."
3. Power Distribution: Readily accessible panelboard in accordance with Section 262416 "Panelboards" installed at [**interior**][**exterior**] location[**coordinated with Architect**]. Include 25 percent provisions for installation of additional future devices.
4. Power Connections:

    a. [**One**]<**Insert number**> duplex, weatherproof, ground-fault circuit interrupter (GFCI), NEMA 5-15R power outlet(s) for servicing exterior equipment.
    b. [**One**][**Two**]<**Insert number**> duplex, [**ground-fault circuit interrupter (GFCI),**] NEMA 5-15R power outlet(s) under counter(s) near access openings.
    c. [**One**][**Two**]<**Insert number**> type USB-A power outlet(s) above counter(s) for charging portable devices.
    d. Provide power connections and means of disconnect for interior and exterior HVAC equipment.
    e. Provide power connections and means of disconnect for vehicle[**and pedestrian**] control equipment.

5. Lighting:

   a. Booth Interior: LED. Provide **20-fc (200-lux)** average horizontal illuminance, with uniformity not exceeding 2:1 average-to-minimum[**, dimmable from 100 percent to 10 percent,**] on counter work surfaces.
   b. Booth Exterior: LED, located above door. Provide not less than **0.5-fc (5-lux)** average horizontal illuminance, with uniformity not exceeding 3:1 maximum-to-minimum, when measured at finished grade over the distance of **15 ft. (4.5 m)** from entrance door.
   c. Vehicle and Pedestrian Circulation:

      1) LZ1: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **2-fc (20-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1.5-fc (15-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
      2) LZ2: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1.5-fc (15-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **1-fc (10-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
      3) LZ3: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **1-fc (10-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.8-fc (8-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.
      4) LZ4: LED. For drive aisles[**and pedestrian walkways**] in primary directions of travel for distance **10 ft. (3 m)** from booth, provide not less than **0.8-fc (8-lux)** average horizontal illuminance when measured **4 ft. (1.2 m)** above finished grade and not less than **0.6-fc (6-lux)** average vertical illuminance when measured **3 to 5 ft. (1 to 1.5 m)** above finished grade, with horizontal and vertical uniformities not exceeding 2:1 average-to-minimum.

   d. Controls: [**Provide manual switches for interior and exterior lighting on wall inside booth door**][**Provide automatic photocontrol for interior and exterior lighting, with manual override located on wall inside booth door**].

N. Communications:

   1. [**One**]<**Insert number**> communications outlet(s) under counter(s) with [**two**][**four**]<**Insert number**> TIA-1096-A miniature eight-position series jack(s) for connecting telephone and data equipment.

O. Heating Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled, [**110-V**][**230/208-V**] electric heater with fan-forced operation and with capacity of not less than [**5000 Btu/h (1470 W)**][**7500 Btu/h (2200 W)**]<**Insert capacity**>. Enclose in enameled-steel cabinet[**and mount under work counter**].

P. Cooling Unit: [**Wall**][**Roof**]-mounted, thermostatically controlled air conditioner with cooling capacity of not less than [**10,000 Btu/h (2930 W)**][**12,000 Btu/h (3520 W)**][**13,500 Btu/h (3960 W)**]<**Insert capacity**>. Enclose in enameled-steel cabinet.

Q. Accessories: Provide the following for each control booth:

1. Through-wall transaction drawers[**and speaking apertures**].
2. Antifatigue mats.
3. Exterior stainless steel counter.
4. [**Floor**][**Wall-mounted**] safe.
5. Signage: <**Insert requirements**>.
6. Ventilation fan.
7. Insect screens on operable openings.
8. Rollup shutters on doors and windows.
9. Intercom.
10. Traffic control lights.
11. Bollards.

R. Anchorage: [**Cast-in-place anchor bolts**][**Postinstalled anchors**] fabricated from stainless steel, with allowable load or strength design greater than or equal to the design load, as determined by testing conducted by a qualified testing agency.

S. Materials:

1. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

   a. Sheet: ASTM B209/B209M.
   b. Extruded Shapes: **ASTM B221 (ASTM B221M)**.
   c. Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T4 or Alloy 6061-T6.

2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
3. Plastic Laminate: ISO 4586-3, Grade HGS or HGL.
4. Plywood: DOC PS 1, Exterior grade.
5. Particleboard: ANSI A208.1, Grade M-2.
6. Clear Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, and Quality q3; [**6 mm thick**]<**Insert thickness**>.
7. Clear Insulating Glass: ASTM E2190. Factory-assembled units consisting of two lites of 2.5-mm-thick clear float glass, ASTM C1036, Type I, Class 1, Quality q3, and dehydrated air space, with a total overall unit thickness of [**1 inch (25 mm)**][**3/4 inch (19 mm)**][**5/8 inch (16 mm)**]<**Insert dimension**> and with manufacturer's standard dual seal. Provide tempered lites where indicated.
8. Ballistic-Resistant Glazing: Tested to comply with bullet-resistant testing level indicated.

T. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

U. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**]<**Insert color**>.

V. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and gloss**>.

2.4 FABRICATION

A. Factory fabricate complete control booths, with accessories and options installed at factory.

B. Factory preglaze windows and doors.

C. Factory prewire control booths, ready for connection to service at Project site.

D. Fabricate control booths with [**forklift pockets in base of booth**][**removable lifting eye centered in roof**].

E. Accessible Control Booths: Where indicated to be accessible, fabricate control booths as follows:

1. Provide service windows located no higher than **34 inches (865 mm)** above exterior grade.
2. Provide door opening with minimum **32-inch (813-mm)** clear width.
3. Provide minimum **60-inch (1525-mm)** clear turning spacing within the booth.
4. Provide minimum **27-inch (685-mm)** clearance beneath interior work surfaces. Locate work surfaces **28 inches (710 mm)** minimum and **34 inches (865 mm)** maximum above the floor.
5. Locate controls and operable parts no lower than **15 inches (381 mm)** and no higher than **48 inches (1219 mm)** above the floor where reach is unobstructed. Where side reach is obstructed, locate controls and operable parts no lower than **15 inches (381 mm)** and no higher than **46 inches (1170 mm)** above the floor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including concrete bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before control booth installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 INSTALLATION

A. Install control booths in accordance with manufacturer's written instructions.

B. Accessible Control Booths: Install with interior floor surface at same elevation as adjacent paved surfaces.

C. Set control booths plumb and aligned. Level baseplates true to plane, with full bearing on concrete bases.

D. Fasten control booths securely to concrete base with anchorage indicated.

E. Connect to electrical power service and communication systems.

F. Perform startup checks of [**heating**][**and**][**cooling**] units in accordance with manufacturer's written instructions.

3.3 ADJUSTING

A. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.

B. Adjust interior and exterior lighting controls.

C. Lubricate hardware and other moving parts.

D. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 01 55 26 00A

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Task	Specification	Specification Description
01 55 26 00	01 00 00 00	General Requirements
01 55 26 00	01 22 00 00	No Specification Required
01 56 00 00	01 00 00 00	General Requirements
01 56 16 00	01 00 00 00	General Requirements
01 56 16 00	01 22 00 00	No Specification Required

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SECTION 01 56 26 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and [**removing site utilities**][**abandoning site utilities in place**].
8. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.2 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than **2 inches (50 mm)** in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

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

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and [**indicated on Drawings**][**indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection."**]<**Insert requirement**>.

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

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

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

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.6 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property

adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises[**where indicated**]<**Insert location**>.

D. Utility Locator Service: Notify [**utility locator service**][**Miss Utility**][**Call Before You Dig**][**Dig Safe System**][**One Call**]<**Insert name**> for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control[**and plant-protection**] measures are in place.

F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with [**MPI #23 (surface-tolerant, anticorrosive metal primer)**][**or**][**SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating**]<**Insert requirement**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion-

and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed[**or abandoned in place**].

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than [**two**]<**Insert number**> days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than [2 inches (50 mm)][3 inches (75 mm)]<**Insert dimension**> in diameter, obstructions, and debris to a depth of [18 inches (450 mm)]<**Insert dimension**> below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and [**stockpile in areas approved by Architect**][**dispose of off-site**]<**Insert requirement**>.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth [**indicated on Drawings**][**of 6 inches (150 mm)**]<**Insert requirement**> in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to [72 inches (1800 mm)]<**Insert dimension**>.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 STOCKPILING ROCK

A. Remove from [**area indicated on Drawings**][**construction area**]<**Insert requirement**> naturally formed rocks that measure more than [1 foot (300 mm)]<**Insert dimension**> across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock [**where indicated on Drawings**][**away from edge of excavations**]<**Insert requirement**> without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to [36 inches (900 mm)]<**Insert dimension**>.
2. Do not stockpile rock within protection zones.
3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus rock to allow later use by the Owner.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 01 56 26 00

Task	Specification	Specification Description
01 56 26 00	01 00 00 00	General Requirements
01 56 26 00	01 22 00 00	No Specification Required
01 56 29 00	01 00 00 00	General Requirements
01 56 29 00	01 22 00 00	No Specification Required
01 56 33 00	01 00 00 00	General Requirements
01 56 33 00	01 22 00 00	No Specification Required

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SECTION 01 56 39 00 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

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

B. Related Requirements:

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

1.2 DEFINITIONS

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

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

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

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

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

1.3 PREINSTALLATION MEETINGS

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

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

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

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

1.4 ACTION SUBMITTALS

A. Product Data:

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

B. Shop Drawings:

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

C. Samples: For each type of the following:

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

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

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

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

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

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

1.5 INFORMATIONAL SUBMITTALS

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

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

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

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

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

E. Quality-control program.

1.6 QUALITY ASSURANCE

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

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

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

1.7 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

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

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

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

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

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

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

3.3 TREE PROTECTION

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

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

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

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

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

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

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

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

3.4 PROTECTION ZONES

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

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

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

C. Maintain protection zones free of weeds and trash.

D. Maintain hydration of plants to assure plant survival.

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

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

3.5 EXCAVATION

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

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

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

3.6 ROOT PRUNING

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

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

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

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

3.7 CROWN PRUNING

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

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

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

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

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

D. Do not paint or apply sealants to wounds.

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

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

3.8 REGRADING

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

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

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

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

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

3.9 FIELD QUALITY CONTROL

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

3.10 REPAIR AND REPLACEMENT

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

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

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

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

a. Species: as directed by the Owner.

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

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

END OF SECTION 01 56 39 00

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Task	Specification	Specification Description
01 56 39 00	01 00 00 00	General Requirements
01 56 39 00	01 22 00 00	No Specification Required
01 57 00 00	01 00 00 00	General Requirements

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SECTION 01 57 23 00 - TEMPORARY STORM WATER POLLUTION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Temporary stormwater pollution controls.

1.2 STORMWATER POLLUTION PREVENTION PLAN

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

1.3 PREINSTALLATION MEETINGS

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

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

1.4 INFORMATIONAL SUBMITTALS

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

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

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

D. Inspection reports.

1.5 QUALITY ASSURANCE

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

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

B. Installers: Trained as indicated in the SWPPP.

PART 2 - PRODUCTS

2.1 TEMPORARY STORMWATER POLLUTION CONTROLS

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

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

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

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

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

END OF SECTION 01 57 23 00

Task	Specification	Specification Description
01 57 23 00	01 00 00 00	General Requirements
01 57 26 00	01 00 00 00	General Requirements
01 58 00 00	01 00 00 00	General Requirements

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SECTION 01 58 13 00 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dimensional characters.

a. Cast dimensional characters.
b. Cutout dimensional characters.
c. Fabricated channel dimensional characters.
d. Illuminated, fabricated channel dimensional characters.
e. Molded-plastic dimensional characters.
f. Illuminated, molded-plastic dimensional characters.

1.2 ALLOWANCES

A. Allowances for [**signage**][**dimensional letter signs**][**illuminated, fabricated channel dimensional characters**]<**Insert item description**> are specified in Section 012100 "Allowances."

B. <**Insert product or material**>[**is**][**are**] part of <**Insert name of allowance**>.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1.4 DEFINITIONS

A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.5 COORDINATION

A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign at least [**half size**]<**Insert scale**>.
4. Show locations of electrical service connections.
5. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

E. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Dimensional Characters: [**Full-size Sample**][**Half-size Sample**]<**Insert size**> of[**each type of**] dimensional character.
2. Exposed Accessories: [**Full-size Sample**][**Half-size Sample**]<**Insert size**> of each accessory type.
3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.

F. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

G. Delegated Design Submittal: For [**signs indicated in "Performance Requirements" Article**]<**Insert sign designations**>.

1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**manufacturer**].

B. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: [**Manufacturer of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.10 FIELD CONDITIONS

A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other

installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Separation or delamination of sheet materials and components.

2. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of [**rooftop**][**dimensional character**]<**Insert description**> sign type(s) <**Insert drawing designation of sign(s)**> according to structural performance requirements.

B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

1. Uniform Wind Load: [**As indicated on Drawings**]<**Insert design load**>.
2. Concentrated Horizontal Load: [**As indicated on Drawings**]<**Insert design load**>.
3. Other Design Load: [**As indicated on Drawings**]<**Insert design load**>
4. Uniform and concentrated loads need not be assumed to act concurrently.

C. Thermal Movements: For exterior [**fabricated channel dimensional characters**]<**Insert item**>, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**]<**Insert temperature change**>.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 DIMENSIONAL CHARACTERS

A. Cast Characters : Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:

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

a. [**A.R.K. Ramos**]

b. [**ACE Sign Systems, Inc.**]
c. [**ASI Sign Systems, Inc**]
d. [**Cosco**]
e. [**Gemini Signage; Gemini, Inc.**]
f. [**Matthews International Corporation; Bronze Division**]
g. [**Metal Arts**]
h. [**Metallic Arts**]
i. [**Southwell Company (The)**]
j. <**Insert manufacturer's name**>

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

a. [**A.R.K. Ramos**]
b. [**ACE Sign Systems, Inc.**]
c. [**ASI Sign Systems, Inc**]
d. [**Cosco**]
e. [**Gemini Signage; Gemini, Inc.**]
f. [**Matthews International Corporation; Bronze Division**]
g. [**Metal Arts**]
h. [**Metallic Arts**]
i. [**Southwell Company (The)**]
j. <**Insert manufacturer's name**>

3. Character Material: Cast [**aluminum**][**brass**][**bronze**][**zinc**]<**Insert material**>.
4. Character Height: [**As indicated on Drawings**]<**Insert dimension**>.
5. Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of character**]<**Insert dimension**>.
6. Finishes:

a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**]<**Insert finish**>.
b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**]<**Insert finish**>.
c. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**]<**Insert color**>.
d. Overcoat: [**Manufacturer's standard baked-on clear coating**][**Clear organic coating**]<**Insert requirement**>.

7. Mounting: [**As indicated on Drawings**][**Concealed studs**][**Projecting studs**][**Rosette-head through fasteners**][**Countersunk flathead through fasteners**]<**Insert requirement**>.
8. Typeface: [**Times Roman**]<**Insert requirement**>.

B. Cutout Characters : Characters with uniform faces; square-cut, smooth[**, eased**] edges; precisely formed lines and profiles; and as follows:

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

a. [**A.R.K. Ramos**]
b. [**ACE Sign Systems, Inc.**]
c. [**APCO Graphics, Inc**]
d. [**ASI Sign Systems, Inc**]
e. [**Cosco**]
f. [**Diskey Sign Company**]
g. [**Gemini Signage; Gemini, Inc.**]
h. [**inpro Corporation**]
i. [**Matthews International Corporation; Bronze Division**]
j. [**Metal Arts**]
k. [**Metallic Arts**]
l. [**Southwell Company (The)**]
m. [**Steel Art Company**]
n. <**Insert manufacturer's name**>

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

a. [**A.R.K. Ramos**]
b. [**ACE Sign Systems, Inc.**]
c. [**APCO Graphics, Inc**]
d. [**ASI Sign Systems, Inc**]
e. [**Cosco**]
f. [**Diskey Sign Company**]
g. [**Gemini Signage; Gemini, Inc.**]
h. [**inpro Corporation**]
i. [**Matthews International Corporation; Bronze Division**]
j. [**Metal Arts**]
k. [**Metallic Arts**]
l. [**Southwell Company (The)**]
m. [**Steel Art Company**]
n. <**Insert manufacturer's name**>

3. Character Material: Sheet or plate [**aluminum**][**brass**][**bronze**][**copper**][**stainless steel**][**zinc**][**acrylic**][**acrylic with laminated aluminum facing**][**acrylic with laminated brass facing**][**acrylic with laminated bronze facing**][**acrylic with laminated stainless steel facing**]<**Insert material**>.
4. Character Height: [**As indicated on Drawings**]<**Insert dimension**>.
5. Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of character**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**]<**Insert dimension**>.
6. Finishes:

a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**]<**Insert finish**>.
b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**]<**Insert finish**>.
c. Integral Stainless Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**]<**Insert description**>.
d. Integral Acrylic Color: [**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**]<**Insert color**>.
e. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**]<**Insert color**>.

f. Overcoat: [**Manufacturer's standard baked-on clear coating**][**Clear organic coating**]<**Insert requirement**>.
g. Painted Edges: Paint edges of acrylic characters with laminated metal facing as recommended in writing by manufacturer.

7. Mounting: [**As indicated on Drawings**][**Concealed studs**][**Projecting studs**][**Rosette-head through fasteners**][**Countersunk flathead through fasteners**][**Concealed, painted aluminum back bar or bracket assembly**][**Concealed, stainless steel back bar or bracket assembly**][**Adhesive**]<**Insert requirement**>.
8. Typeface: [**Times Roman**]<**Insert requirement**>.

C. Fabricated Channel Characters : [**Metal face and side returns**][**Open face with metal side returns**][**Translucent face with metal side returns**], formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.

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

a. [**A.R.K. Ramos**]
b. [**ACE Sign Systems, Inc.**]
c. [**Allen Industries**]
d. [**APCO Graphics, Inc**]
e. [**ASI Sign Systems, Inc**]
f. [**Charleston Manufacturing, LLC**]
g. [**Cosco**]
h. [**Gemini Signage; Gemini, Inc.**]
i. [**Metallic Arts**]
j. [**Signs & Decal Corp**]
k. [**Steel Art Company**]
l. <**Insert manufacturer's name**>

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

a. [**A.R.K. Ramos**]
b. [**ACE Sign Systems, Inc.**]
c. [**Allen Industries**]
d. [**APCO Graphics, Inc**]
e. [**ASI Sign Systems, Inc**]
f. [**Charleston Manufacturing, LLC**]
g. [**Cosco**]
h. [**Gemini Signage; Gemini, Inc.**]
i. [**Metallic Arts**]
j. [**Signs & Decal Corp**]
k. [**Steel Art Company**]
l. <**Insert manufacturer's name**>

3. Illuminated Characters: [**Backlighted**][**Frontlighted**] character construction with [**fluorescent tube**][**fiber-optic**][**LED**][**neon tube**]<**Insert requirement**> lighting, including transformers, insulators, and other accessories for operability, with provision for servicing and concealing

connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.

a. Power: [**As indicated on electrical Drawings**][**120 V, 60 Hz, 1 phase, 15 A**]<**Insert requirement**>.
b. Weeps: Provide weep holes to drain water at lowest part of exterior characters.[**Equip weeps with permanent baffles to block light leakage without inhibiting drainage.**]

4. Character Material: Sheet or plate [**aluminum**][**brass**][**bronze**][**copper**][**steel**][**stainless steel**][**zinc**]<**Insert material**>.
5. Material Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size and design of character**][**0.100 inch (2.54 mm)**][**0.032 inch (0.81 mm)**][**Nominal 0.048 inch (1.21 mm) thick for face and 0.030 inch (0.76 mm) thick for returns**][**0.050 inch (1.27 mm) thick for face and 0.031 inch (0.79 mm) thick for returns**]<**Insert dimension(s)**>.
6. Translucent Face Sheet: Acrylic sheet with integral color [**matching Architect's sample**][**as selected by Architect from manufacturer's full range**]<**Insert color**>.

a. Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard thickness for size of character**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**]<**Insert dimension**>.

7. Character Height: [**As indicated on Drawings**]<**Insert dimension**>.
8. Character Depth: [**As indicated on Drawings**]<**Insert dimension**>.
9. Finishes:

a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**]<**Insert finish**>.
b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**]<**Insert finish**>.
c. Integral Stainless Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**]<**Insert description**>.
d. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**]<**Insert color**>.
e. Overcoat: [**Manufacturer's standard baked-on clear coating**][**Clear organic coating**]<**Insert requirement**>.

10. Mounting: [**As indicated on Drawings**][**Manufacturer's standard for size and design of character**][**Projecting studs**][**Concealed, painted aluminum back bar or bracket assembly**][**Concealed, stainless steel back bar or bracket assembly**]<**Insert requirement**>.

a. Hold characters at [**2-inch (51-mm) distance**][**manufacturer's recommended distance**][**distance as selected by Architect**]<**Insert dimension**> from wall surface.

11. Typeface: [**Times Roman**]<**Insert requirement**>.

D. Molded-Plastic Characters : [**Injection molded**][**or**][**thermoformed**] characters having uniform faces and profiles, and as follows:

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

a. [**ACE Sign Systems, Inc.**]
b. [**ASI Sign Systems, Inc**]
c. [**Cosco**]
d. [**Gemini Signage; Gemini, Inc.**]
e. [**Metallic Arts**]
f. [**Signs & Decal Corp**]
g. <**Insert manufacturer's name**>

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

a. [**ACE Sign Systems, Inc.**]
b. [**ASI Sign Systems, Inc**]
c. [**Cosco**]
d. [**Gemini Signage; Gemini, Inc.**]
e. [**Metallic Arts**]
f. [**Signs & Decal Corp**]
g. <**Insert manufacturer's name**>

3. Illuminated Characters: Characters with concealed [**fluorescent tube**][**fiber-optic**][**LED**][**neon tube**] lighting, including transformers, insulators, and other accessories; with provision for servicing and concealing connections to building electrical system. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.

a. Power: [**As indicated on electrical Drawings**][**120 V, 60 Hz, 1 phase, 15 A**]<**Insert requirement**>.
b. Weeps: Provide weep holes to drain water at lowest part of exterior characters.[**Equip weeps with permanent baffles to block light leakage without inhibiting drainage.**]

4. Color: Manufacturer's standard [**integral color**][**painted finish**] process, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**]<**Insert color**>.
5. Typeface: [**Times Roman**]<**Insert requirement**>.

2.3 DIMENSIONAL CHARACTER MATERIALS

A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

B. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

D. Brass Castings: ASTM B584, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C85200 (high-copper yellow brass)**]<**Insert requirement**>.

E. Brass Sheet (Yellow Brass): ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C26000 (yellow brass)**]<**Insert requirement**>.

F. Bronze Castings: ASTM B584, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C86500 (No. 1 manganese bronze)**]<**Insert requirement**>.

G. Bronze Plate: ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C22000 (commercial bronze)**]<**Insert requirement**>.

H. Copper Sheet: ASTM B152/B152M.

I. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304,**][**Type 316,**] stretcher-leveled standard of flatness.

J. Zinc Castings: ASTM B240, alloy and temper recommended by sign manufacturer for type of use and finish indicated.

K. Zinc Sheet: [**ASTM B69**]<**Insert standard**>, alloy and temper recommended by sign manufacturer for type of use and finish indicated.

L. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

M. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish [**nonferrous-metal**][**stainless steel**][**or**][**hot-dip galvanized**]<**Insert requirement**> devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

    a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
    b. Fastener Heads: For nonstructural connections, use [**flathead**][**or**][**oval countersunk**]<**Insert shape**> screws and bolts with tamper-resistant [**Allen-head**][**spanner-head**][**or**][**one-way-head**]<**Insert slot design**> slots unless otherwise indicated.

4. Sign Mounting Fasteners:

    a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

B. Adhesive: As recommended by sign manufacturer.

1. Adhesives shall have a VOC content of [**70**]<**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish [**to match sign-background color**][**to match Architect's sample**]<**Insert requirement**> color unless otherwise indicated.
2. Stainless Steel Brackets: Factory finish brackets [**to match sign background**][**to match Architect's sample**][**with No. 4**]<**Insert finish**> finish unless otherwise indicated.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.8 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Directional Satin Finish: No. 4.
3. Dull Satin Finish: No. 6.
4. Reflective, Directional Polish: No. 7.
5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

2.9 LACQUER COATING FOR COPPER-ALLOY FINISHES

A. Lacquer Coating: Clear, organic, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of acrylic resin, methyl methacrylate copolymer, leveling agent, and corrosion inhibitor benzotriazole.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that electrical service is correctly sized and located to accommodate signs.

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

3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

    a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

    a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
    b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign

without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 01 58 13 00

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SECTION 01 58 13 00A - PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panel signs.
2. Field-applied, vinyl-character signs.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary Project identification signs and for temporary informational and directional signs.
2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection-zone signage.
3. Section 101300 "Directories" for building directories.
4. Section 101423.16 "Room-Identification Panel Signage" for room-identification signs that are directly attached to the building.
5. Section 101426 "Post and Panel/Pylon Signage" for freestanding signs.
6. [**Section 142100 "Electric Traction Elevators"**][**Section 142400 "Hydraulic Elevators"**][**Section 143100 "Escalators"**][**Section 143200 "Moving Walks"**][**Section 144200 "Wheelchair Lifts"**] for code-required conveying equipment signage.
7. Section 220553 "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
8. Section 230553 "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
9. Section 260553 "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
10. Section 265213 "Emergency and Exit Lighting" for illuminated, self-luminous, and photoluminescent exit sign units.

1.2 ALLOWANCES

A. Allowances for [**signage**][**panel signs**]<**Insert item description**> are specified in Section 012100 "Allowances."

B. <**Insert product or material**>[**is**][**are**] part of <**Insert name of allowance**>.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1.4 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

B. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.5 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.6 ACTION SUBMITTALS

A. Product Data:

1. Panel signs.
2. Field-applied, vinyl-character signs.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For panel signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements[**, including raised characters and Braille**], and layout for each sign at least [**half size**]<**Insert scale**>.
4. Show locations of electrical service connections.
5. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

E. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Panel Signs: [**Full-size Sample**][**Not less than 12 inches (300 mm) square, including corner**]<**Insert size**>.
2. Field-Applied, Vinyl-Character Signs: [**Full-size Sample of characters on glass**]<**Insert requirement**>.
3. Variable Component Materials: [**Full-size Sample**][**8-inch (200-mm) Sample**]<**Insert size**> of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
4. Exposed Accessories: [**Full-size Sample**][**Half-size Sample**]<**Insert size**> of each accessory type.
5. Full-size Samples, if approved, will be returned to Contractor for use in Project.

F. Product Schedule: For panel signs. Use same designations indicated on Drawings or specified.

G. Delegated Design Submittals: For [**signs indicated in "Performance Requirements" Article**]<**Insert sign designations**>.

1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**and**][**manufacturer**].

B. Evaluation Reports: For [**post-installed anchors**][**and**][**power-actuated fasteners**], from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

C. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[**, from the same product run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Variable Component Materials: [**12**]<**Insert number**> replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
2. Tools: [**One**]<**Insert number**> set(s) of specialty tools for assembling signs and replacing variable sign components.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: [**Manufacturer of products**][**An entity that employs installers and supervisors who are trained and approved by manufacturer**].

1.11 FIELD CONDITIONS

A. Field Measurements: Verify locations of [**anchorage devices**][**and**][**electrical service**] embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of [**rooftop**][**illuminated panel**]<**Insert description**> sign type(s) <**Insert drawing designation of sign(s)**> according to structural performance requirements.

B. Structural Performance: Signs and supporting elements are to withstand the effects of gravity and other loads within limits and under conditions indicated.

1. Uniform Wind Load: [**As indicated on Drawings**]<**Insert design load**>.
2. Concentrated Horizontal Load: [**As indicated on Drawings**]<**Insert dimension**>.
3. Other Design Load: [**As indicated on Drawings**]<**Insert dimension**>.
4. Uniform and concentrated loads need not be assumed to act concurrently.

C. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**]<**Insert temperature change**>.

D. Accessibility Standard: Comply with applicable provisions in [**the USDOJ's "2010 ADA Standards for Accessible Design"**][**the ABA standards of the Federal agency having jurisdiction**][**and**][**ICC A117.1**]<**Insert requirement**>.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PANEL SIGNS

A. Panel Sign : Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

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

a. [**ACE Sign Systems, Inc.**]
b. [**Advance Corporation**]
c. [**Allen Industries**]
d. [**Allen Markings**]
e. [**APCO Graphics, Inc**]
f. [**ASE, Inc**]
g. [**ASI Sign Systems, Inc**]
h. [**Best Sign Systems, Inc.**]
i. [**Bunting Graphics, Inc**]
j. [**Clarke Systems**]
k. [**Cosco**]
l. [**Diskey Sign Company**]
m. [**Foresight Supersign**]

n. [**Fossil Industries, Inc.**]
o. [**inpro Corporation**]
p. [**Mohawk Sign Systems**]
q. [**Nelson-Harkins Industries**]
r. [**Poblocki Sign Company, LLC**]
s. [**Seton Identification Products; a Brady Corporation company**]
t. [**Signs & Decal Corp**]
u. [**Vista System, LLC**]
v. [**Vomar Products, Inc**]
w. <**Insert manufacturer's name**>

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

a. [**ACE Sign Systems, Inc.**]
b. [**Advance Corporation**]
c. [**Allen Industries**]
d. [**Allen Markings**]
e. [**APCO Graphics, Inc**]
f. [**ASE, Inc**]
g. [**ASI Sign Systems, Inc**]
h. [**Best Sign Systems, Inc.**]
i. [**Bunting Graphics, Inc**]
j. [**Clarke Systems**]
k. [**Cosco**]
l. [**Diskey Sign Company**]
m. [**Foresight Supersign**]
n. [**Fossil Industries, Inc.**]
o. [**inpro Corporation**]
p. [**Mohawk Sign Systems**]
q. [**Nelson-Harkins Industries**]
r. [**Poblocki Sign Company, LLC**]
s. [**Seton Identification Products; a Brady Corporation company**]
t. [**Signs & Decal Corp**]
u. [**Vista System, LLC**]
v. [**Vomar Products, Inc**]
w. <**Insert manufacturer's name**>

3. Illuminated Panel Sign: [**Backlighted**][**Edgelighted**] construction with [**fluorescent tube**][**fiber-optic**][**LED**][**neon tube**]<**Insert requirement**> lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from sign surfaces as needed to illuminate evenly.

a. Power: [**As indicated on electrical Drawings**][**120 V, 60 Hz, 1 phase, 15 A**]<**Insert requirement**>.
b. Weeps: Provide weep holes to drain water at lowest part of exterior signs.[**Equip weeps with permanent baffles to block light leakage without inhibiting drainage.**]

4. Solid-Sheet Sign: [**Aluminum**][**Brass**][**Bronze**][**Copper**][**Steel**][**Stainless steel**][**Acrylic**][**Fiberglass**][**PVC**]<**Insert material**> sheet [**and returns**][**, returns, and back**] with finish specified in "Surface Finish and Applied Graphics" Subparagraph and as follows:

a. Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.060**

inch (1.52 mm)][0.080 inch (2.03 mm)][0.125 inch (3.18 mm)][0.25 inch (6.35 mm)]<**Insert dimension**>.

b. Surface-Applied, Flat Graphics: Applied [**vinyl film**][**baked enamel or powder coat**][**paint**][**photo image**]<**Insert requirement**>.
c. Surface-Applied, Raised Graphics: Applied [**polymer characters**][**and**][**Braille**]<**Insert requirement**>.
d. Etched and Filled Graphics: Sign face etched or routed to receive enamel-paint infill.
e. Inset, Cutout Characters: Sign face routed to receive push-through acrylic graphics [**flush with**][**slightly projecting from**] the sign panel.

5. Laminated Aluminum-Sheet Sign: Aluminum sheet laminated to both sides of [**acrylic**][**phenolic**]<**Insert material**> core sheet[**with painted edges**].

a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**]<**Insert dimension**>.
b. Surface-Applied, Flat Graphics: Applied [**vinyl film**][**paint**][**photo image**]<**Insert requirement**>.
c. Surface-Applied, Raised Graphics: Applied [**polymer characters**][**and**][**Braille**]<**Insert requirement**>.

6. Laminated-Sheet Sign: [**Photopolymer**][**Sandblasted polymer**]<**Insert material**> face sheet with raised graphics laminated[**over subsurface graphics**] to [**acrylic**][**phenolic**]<**Insert material**> backing sheet to produce composite sheet.

a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**]<**Insert dimension**>.
b. Surface-Applied, Flat Graphics: Applied [**vinyl film**][**paint**][**photo image**]<**Insert requirement**>.
c. Surface-Applied, Raised Graphics: Applied [**polymer characters**][**and**][**Braille**]<**Insert requirement**>.
d. Subsurface Graphics: [**Reverse halftone or dot-screen image**][**Reverse etch image**][**Snap-in changeable insert beneath removable face sheet**][**Slide-in changeable insert**]<**Insert requirement**>.

7. Composite Phenolic-Core Sign: Solid phenolic panel core with integral subsurface graphic image covered with integral, polymeric face layer.

a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.5 inch (12.7 mm)**][**1 inch (25.4 mm)**]<**Insert dimension**>.

8. Laminated Polycarbonate-Sheet Sign: Polycarbonate face sheet laminated to each side of [**phenolic**]<**Insert material**> base sheet to produce composite sheet.

a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**]<**Insert dimension**>.
b. Surface-Applied, Flat Graphics: Applied [**vinyl film**][**paint**][**photo image**]<**Insert requirement**>.
c. Surface-Applied, Raised Graphics: Applied [**polymer characters**][**and**][**Braille**]<**Insert requirement**>.
d. Subsurface Graphics: [**Reverse halftone or dot-screen image**][**Reverse etch image**]<**Insert requirement**>.

9. Engraved Plastic-Laminate Sign: Plastic-laminate face laminated to contrasting phenolic core to produce composite sheet.

a. Composite-Sheet Thickness: [**As indicated on Drawings**][**Manufacturer's standard for size of sign**][**0.125 inch (3.18 mm)**][**0.25 inch (6.35 mm)**]<**Insert dimension**>.
b. Engraved Graphics: Characters engraved through plastic-laminate face sheet to expose contrasting phenolic core.
c. Plastic-Laminate Color and Pattern: [**As indicated by manufacturer's designation**][**As selected by Architect from manufacturer's full range**]<**Insert color and pattern**>.
d. Core Color: Manufacturer's standard [**dark color**]<**Insert color**>.

10. Sign-Panel Perimeter: Finish edges smooth.

    a. Edge Condition:

        1) Vertical Edges: [**As indicated on Drawings**][**Square cut**][**Beveled**][**Bullnosed**]<**Insert requirement**>.
        2) Horizontal Edges: [**As indicated on Drawings**][**Square cut**][**Beveled**][**Bullnosed**]<**Insert requirement**>.

    b. Corner Condition in Elevation: [**As indicated on Drawings**][**Square**][**Rounded to radius indicated**]<**Insert requirement**>.

11. Frame: [**Entire perimeter**][**Horizontal retainers**][**Vertical retainers**][**to hold changeable sign panel**]<**Insert description**>.

    a. Material: [**Aluminum**][**Brass**][**Bronze**][**Steel**][**Stainless steel**][**PVC**]<**Insert material**>.
    b. Material Thickness: <**Insert dimension**>.
    c. Frame Depth: [**As indicated on Drawings**]<**Insert dimension**>.
    d. Profile: [**Square**][**Beveled**][**Rounded**]<**Insert requirement**>.
    e. Corner Condition in Elevation: [**Square**][**Mitered**][**Rounded to radius indicated**]<**Insert requirement**>.
    f. Finish and Color: [**Mill**][**Painted, matte black color**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert requirement**>.

12. Mounting: [**As indicated on Drawings**][**Manufacturer's standard method for substrates indicated**][**Surface mounted to wall**][**Projecting from wall**][**Suspended**][**Aluminum bracket**][**Stainless steel bracket**]<**Insert requirement**> with [**concealed anchors**][**countersunk flathead through fasteners**][**adhesive**][**two-face tape**][**hook-and-loop tape**][**or**][**magnetic tape**].
13. Surface Finish and Applied Graphics:

    a. Integral Metal Finish: [**Mill**][**Antique oxidized**][**As indicated by manufacturer's designation**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**]<**Insert finish**>.
    b. Integral Aluminum Finish: [**Clear anodized**][**Light bronze anodized**][**Medium bronze anodized**][**Match Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**]<**Insert finish**>.
    c. Integral Stainless Steel Finish: [**No. 4**][**No. 8**][**Match Architect's sample**][**As selected by Architect from full range of industry finishes**]<**Insert description**>.
    d. Integral Sheet Color: [**Acrylic**][**Fiberglass**][**PVC**] sheet with color [**as indicated by manufacturer's designation**][**to match Architect's sample**][**as selected by Architect from full range of industry colors**]<**Insert color**>.
    e. Baked-Enamel or Powder-Coat Finish and Graphics: Manufacturer's standard, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect from manufacturer's full range**]<**Insert color**>.
    f. Painted Finish and Graphics: Manufacturer's standard, factory-applied [**exterior-grade sign paint**][**acrylic polyurethane**]<**Insert requirement**>, in color [**as indicated by manufacturer's designation**][**matching Architect's sample**][**as selected by Architect**

from manufacturer's full range]<**Insert color**>.

g. Photo-Image Graphics: Manufacturer's standard [**black-and-white**][**multicolor**], [**600-dpi**]<**Insert value**> halftone or dot-screen image.

h. Overcoat: [**Manufacturer's standard baked-on clear coating**]<**Insert requirement**>.

14. Text and Typeface: [**Accessible raised characters and Braille**][**Times Roman**][**typeface as indicated by manufacturer's designation**][**typeface matching Architect's sample**][**typeface as selected by Architect from manufacturer's full range**][**and**][**variable content as scheduled**]<**Insert requirement**>.[**Finish raised characters to contrast with background color, and finish Braille to match background color.**]

15. Flatness Tolerance: Sign is to remain flat or uniformly curved under installed conditions as indicated on Drawings and within a tolerance of plus or minus [**1/16 inch (1.5 mm)**]<**Insert dimension**> measured diagonally from corner to corner.

2.3 FIELD-APPLIED, VINYL-CHARACTER SIGNS

A. Field-Applied, Vinyl-Character Sign : Prespaced characters die cut from [**3- to 3.5-mil (0.076- to 0.089-mm)**]<**Insert dimensions**> thick, weather-resistant vinyl film with release liner on the back and carrier film on the front for on-site alignment and application.

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

   a. [**Allen Markings**]
   b. [**APCO Graphics, Inc**]
   c. [**inpro Corporation**]
   d. [**Mohawk Sign Systems**]
   e. [**Seton Identification Products; a Brady Corporation company**]
   f. <**Insert manufacturer's name**>

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

   a. [**Allen Markings**]
   b. [**APCO Graphics, Inc**]
   c. [**inpro Corporation**]
   d. [**Mohawk Sign Systems**]
   e. [**Seton Identification Products; a Brady Corporation company**]
   f. <**Insert manufacturer's name**>

3. Size: [**As indicated on Drawings**][**As scheduled**]<**Insert requirement**>.
4. Substrate: [**As indicated on Drawings**][**As scheduled**][**Glass**][**Doors**][**Walls**]<**Insert substrate**>.
5. Text and Font: [**As indicated on Drawings**][**As scheduled**]<**Insert requirement**>.

2.4 PANEL-SIGN MATERIALS

A. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Brass Sheet (Yellow Brass): ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C26000 (yellow brass)**]<**Insert requirement**>.

D. Bronze Plate: ASTM B36/B36M, [**alloy recommended by manufacturer and finisher for finish indicated**][**lead-free alloy recommended by manufacturer and finisher for finish indicated**][**Alloy UNS No. C22000 (commercial bronze)**]<**Insert requirement**>.

E. Copper Sheet: ASTM B152/B152M.

F. Steel Materials:

1. Metallic-Coated Steel Sheet: ASTM A653/A653M, [**G90 (Z275)**]<**Insert coating designation**> coating, either commercial or forming steel.
2. Steel Sheet: [**Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, Type B, exposed**][**or**][**electrolytic zinc-coated, ASTM A879/A879M, Coating Designation 08Z (24G), with steel-sheet substrate according to ASTM A1008/A1008M, commercial steel, exposed**].
3. Steel Members Fabricated from Plate or Bar Stock: ASTM A529/A529M or ASTM A572/A572M, **42,000-psi (290-MPa)** minimum yield strength.
4. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.

G. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304,**][**Type 316,**] stretcher-leveled standard of flatness.

H. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

I. Fiberglass Sheet: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.

J. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.

K. PVC Sheet: Manufacturer's standard, UV-light stable, PVC plastic.

L. Plastic-Laminate Sheet: ISO 4586-3, Grade HGS.

M. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.

N. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.5 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish [**nonferrous-metal**][**stainless steel**][**or**][**hot-dip galvanized**]<**Insert requirement**> devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

    a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
    b. Fastener Heads: For nonstructural connections, use [**flathead**][**or**][**oval countersunk**]<**Insert shape**> screws and bolts with tamper-resistant [**Allen-head**][**spanner-head**][**or**][**one-way-head**]<**Insert slot design**> slots unless otherwise indicated.

4. Sign Mounting Fasteners:

    a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
    b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
    c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.

5. Inserts: Furnish inserts to be set by other installers into concrete or masonry work.

B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on [**ICC-ES AC01**][**ICC-ES AC193**][**ICC-ES AC58**][**or**][**ICC-ES AC308**] as appropriate for the substrate.

1. Uses: Securing signs with imposed loads to structure.
2. Type: [**Torque-controlled, expansion anchor**][**torque-controlled, adhesive anchor**][**or**][**adhesive anchor**].
3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Adhesive: As recommended by sign manufacturer.

1. Adhesives shall have a VOC content of [**70**]<**Insert value**> g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical

Emissions from Indoor Sources Using Environmental Chambers."

6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, **0.045 inch (1.14 mm)** thick, with adhesive on both sides.

F. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.

G. Magnetic Tape: Manufacturer's standard magnetic tape with adhesive on one side.

H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into indicated sign surface to produce precisely formed copy, incised to uniform depth.

1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
3. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
4. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.

C. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image is to be free of rough edges.

D. Subsurface-Engraved Graphics: Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

E. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

F. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:

1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. [**Subsequent changeable inserts are by Owner**][**Furnish two blank inserts for each sign for Owner's use**]<**Insert requirement**>.
2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. [**Subsequent changeable inserts are by Owner**][**Furnish two blank inserts for each sign for Owner's use**]<**Insert requirement**>.
3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel. [**Subsequent changeable sign panels are by Owner**]<**Insert requirement**>.

G. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish [**to match sign-background color**][**to match Architect's sample**]<**Insert requirement**> color unless otherwise indicated.
2. Stainless Steel Brackets: Factory finish brackets [**to match sign background**][**to match Architect's sample**][**with No. 4**]<**Insert finish**> finish unless otherwise indicated.

2.7 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.9 METALLIC-COATED STEEL FINISHES

A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not

leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

B. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the organic coating to be applied over it.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

2.10 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, and prepare for coating according to coating manufacturer's written instructions.

1. For Baked-Enamel or Powder-Coat Finish: After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

B. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.

C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.

2.11 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Directional Satin Finish: No. 4.
3. Dull Satin Finish: No. 6.
4. Reflective, Directional Polish: No. 7.
5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.

D. Verify that electrical service is correctly sized and located to accommodate signs.

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

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Accessible Signage: Install in locations on walls [**as indicated on Drawings**][**and**][**according to the accessibility standard**]<**Insert requirement**>.

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris.

Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

7. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips [**0.250 inch (6.35 mm)**]<**Insert dimension**> away from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; push and rub well to fully engage tape adhesive to substrate.
8. Magnetic Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position.
9. Shim-Plate Mounting: Provide **1/8-inch- (3-mm-)** thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using <**Insert mounting method**> method specified above.

D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.

E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign and two-face tape.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 01 58 13 00A

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Task	Specification	Specification Description
01 58 13 00	01 00 00 00	General Requirements
01 58 13 00	01 22 00 00	No Specification Required

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SECTION 01 60 00 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

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

B. Related Requirements:

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

1.2 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

1.3 QUALITY ASSURANCE

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

1. Resolution of Compatibility Disputes between Multiple Contractors:

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

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

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

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

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

1.4 COORDINATION

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

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

B. Delivery and Handling:

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

C. Storage:

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

1.6 PRODUCT WARRANTIES

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

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

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

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

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

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

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

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

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

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

B. Product Selection Procedures:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Division 01 sustainability requirements Section and individual Specification Sections.

2.2 COMPARABLE PRODUCTS

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

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

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

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

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

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

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00 00

Task	Specification	Specification Description
01 60 00 00	01 00 00 00	General Requirements
01 66 00 00	01 00 00 00	General Requirements
01 66 00 00	01 60 00 00	Product Requirements
01 66 19 00	01 00 00 00	General Requirements
01 66 19 00	01 22 00 00	No Specification Required
01 66 19 00	01 60 00 00	Product Requirements
01 70 00 00	01 00 00 00	General Requirements
01 71 00 00	01 00 00 00	General Requirements
01 71 13 00	01 00 00 00	General Requirements
01 71 13 00	01 22 00 00	No Specification Required
01 71 23 00	01 00 00 00	General Requirements
01 71 23 16	01 00 00 00	General Requirements
01 71 36 00	01 00 00 00	General Requirements
01 74 00 00	01 00 00 00	General Requirements
01 74 13 00	01 00 00 00	General Requirements
01 74 16 00	01 00 00 00	General Requirements
01 74 16 00	01 22 00 00	No Specification Required

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SECTION 01 74 19 00 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

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

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

B. Related Requirements:

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

1.2 DEFINITIONS

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

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

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

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

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

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

1.3 MATERIALS OWNERSHIP

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

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

be uncovered during demolition remain the property of Owner.

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

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

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

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

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

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

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

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

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

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

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

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

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

1.6 QUALITY ASSURANCE

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

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

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

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

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

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

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

1.7 WASTE MANAGEMENT PLAN

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

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

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

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

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

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

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

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

1. Demolition Waste:

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

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

2. Construction Waste:

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

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

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

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

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

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

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

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

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

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

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

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

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

3.2 SALVAGING DEMOLITION WASTE

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

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

1. Clean salvaged items.

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

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

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

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

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

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

G. Plumbing Fixtures: Separate by type and size.

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

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

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

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

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

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

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

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

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

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

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

3.4 RECYCLING DEMOLITION WASTE

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

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

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

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

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

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

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

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

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

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

F. Metals: Separate metals by type.

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

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

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

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

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

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

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

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

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

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

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

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

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

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

B. Wood Materials:

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

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

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

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

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

D. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

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

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

areas.

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

C. Burning: Do not burn waste materials.

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

3.7 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

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

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

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

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

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

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

END OF SECTION 01 74 19 00

Task	Specification	Specification Description
01 74 19 00	01 00 00 00	General Requirements
01 74 19 00	01 22 00 00	No Specification Required
01 74 23 00	01 00 00 00	General Requirements

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SECTION 01 91 13 00 - COMMISSIONING OF FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Cx process requirements for the following fire-suppression systems, assemblies, and equipment:

a. Water-based fire-suppression systems.
b. Fire-extinguishing systems.
c. Fire pumps.
d. Fire-suppression water storage.
e. <**Insert additional systems**>.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 21 Sections specifying fire-suppression systems, system components, equipment, and products.

1.2 DEFINITIONS

A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

C. IgCC: International Green Construction Code.

D. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fire-suppression testing technician.

B. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Contractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and NFPA 3 and to resolve any issues with the CxA.
2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to fire-suppression system to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements" and NFPA 3.

C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, provide the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

    a. Instrument or tool identification number.
    b. Equipment schedule designation of equipment for which the instrument or tool is required.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.4 QUALITY ASSURANCE

A. Fire-Suppression Testing Technician Qualifications: Technicians to perform fire-suppression Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of fire-suppression system, electrical concepts, and building operations.
2. Minimum [**three years'**]<**Insert time**> experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Clean-Agent Fire-Suppression Systems Testing Technician Qualifications: Technicians to perform clean-agent fire-suppression system Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in mechanical systems, fire-suppression systems, or similar field. Degree requirement may be offset by three years' experience in servicing fire-suppression systems in the clean-agent fire-suppression systems industry. Generally, required knowledge includes clean-agent fire-suppression systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of fire-suppression system equipment, assemblies, and systems.
2. Minimum [**three years'**]<**Insert time**> experience installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment

included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

a. Be calibrated by manufacturer with current calibration tags permanently affixed.
b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
c. Fire-suppression system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

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

3.1 Cx PROCESS

A. Perform Cx process for fire-suppression system in accordance with the following:

1. Section 019113 "General Commissioning Requirements."
2. NFPA 3.
3. [**IgCC, which requires compliance with ASHRAE 202.**]
4. [**Cx standards acceptable to the authority having jurisdiction.**]
5. <**Insert standard**>.

3.2 CONSTRUCTION CHECKLISTS

A. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each fire-suppression system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in NFPA 3 [**and IgCC**]<**Insert Cx standard**>. Contractor performs the following:

1. Review fire-suppression system preliminary construction checklists and provide written comments on Construction Checklist items where appropriate.
2. Return preliminary Construction Checklist with review comments within [**10**]<**Insert number**> days of receipt.
3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
4. Use only construction checklists marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.

B. Prepare preliminary detailed construction checklists for each fire-suppression system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**NFPA 3**][**and IgCC**]<**Insert Cx standard**>.

1. Submit preliminary construction checklists to CxA and Designer for review.
2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
3. Use only construction checklists marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.

C. Systems Required to Be Commissioned under IgCC:

1. Water-pumping and -mixing systems over **5 hp (4 kW)** and purification systems.

D. Additional Systems Required to Be Commissioned:

1. Facility fire-suppression water-distribution piping outside the building, including the following:

   a. Fire-suppression water piping, fittings, and specialties outside the building.
   b. Hydrants and fire-department connections.
   c. Fire-alarm devices.
   d. Meters and meter pits.
   e. Outdoor water-storage tanks.
   f. Sleeves and sleeve seals.
   g. Meters and gauges.
   h. General-duty and specialty valves.
   i. Hangers and supports.
   j. Heat tracing.
   k. Vibration isolation[**and seismic restraints**].
   l. Identification.
   m. Insulation.

2. Fire-suppression standpipes, including the following:

   a. Fire-suppression water piping, fittings, and specialties inside the building.
   b. Fire-department connections.
   c. Fire pumps, motors, accessories, and controls.
   d. Pressure-maintenance pumps, motors, accessories, and controls.
   e. Sleeves and sleeve seals.
   f. Indoor water-storage tanks.
   g. Meters and gauges.
   h. General-duty and specialty valves.
   i. Hangers and supports.
   j. Heat tracing.
   k. Vibration isolation[**and seismic restraints**].
   l. Identification.
   m. Insulation.

3. Fire-suppression sprinkler systems, including the following:

   a. Wet-pipe sprinkler piping, fittings, sprinklers, and specialties.
   b. Dry-pipe sprinkler piping, fittings, sprinklers, and specialties.
   c. Pre-action, deluge sprinkler piping, fittings, sprinklers, and specialties.
   d. Fire pumps, motors, accessories, and controls.
   e. Pressure-maintenance pumps, motors, accessories, and controls.
   f. Compressed-air piping, compressors, motors, accessories, and controls.
   g. Sleeves and sleeve seals.
   h. Meters and gauges.
   i. General-duty and specialty valves.
   j. Hangers and supports.
   k. Heat tracing.
   l. Vibration isolation[**and seismic restraints**].
   m. Identification.
   n. Insulation.

4. Clean-agent fire-extinguishing systems, including the following:

a. Piping, fittings, outlets, and specialties.
b. Storage tanks, manifolds, mounting devices, controls, and accessories.
c. Sleeves and sleeve seals.
d. Meters and gauges.
e. General-duty and specialty valves.
f. Hangers and supports.
g. Vibration isolation[**and seismic restraints**].
h. Identification.
i. Insulation.

5. Documentation:

a. Fire-suppression system operating manuals.
b. Documentation of required Cx.
c. Documentation of required operator training.

6. <**Insert additional systems**>.

3.3 Cx TESTING PREPARATION

A. Certify that fire-suppression systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that fire-suppression system instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved submittals, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the fire-suppression system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

3.5 Cx TESTS COMMON TO FIRE-SUPPRESSION SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response compared to acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 21 Sections specifying fire-suppression systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

3.6 CONSTRUCTION CHECKLIST EXAMPLES

A. Vibration Isolation in Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration[**and seismic**] control devices specified in [**Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."**][**Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."**]
2. Components to Be Tested:

    a. Vibration isolation control devices in water-based fire-suppression systems.
    b. [**Seismic control devices for proper device selection and installation.**]
    c. Support systems.

3. Test Purpose: Evaluate effectiveness of vibration isolation[**and proper installation of seismic**] control devices.
4. Test Conditions: Measure vibration of the facility structure at [**three**]<**Insert number**> locations designated by Owner's witness while the isolated equipment operates.

    a. Maximum speed.
    b. Minimum speed.
    c. Critical speed.

5. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

B. Supervision of Fire-Protection Valves in Water-Based Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for valves specified in the following Sections:

    a. Section 210523 "General-Duty Valves for Water-Based Fire Protection Piping."
    b. Section 211000 "Water-Based Fire-Suppression Systems."
    c. Section 284600 "Fire Detection and Alarm."

d. Section 284614 "Single- and Multiple-Station Alarms."
e. Section 331415 "Site Water Distribution Piping."

2. Equipment and Systems to Be Tested:

a. Supervised valves in water-based fire-suppression systems.
b. Division 28 fire-detection and -alarm systems.

3. Test Purpose: Verify generation of supervisory alarm at the fire-alarm control panel in response to activation of valve supervision device or tamper switch.
4. Test Conditions:

a. Fire-alarm system operating in normal, automatic mode.
b. Activate valve supervision devices and tamper switches, one at a time.

5. Acceptance Criteria: Activation of valve supervision device or tamper switch generates supervisory alarm at fire-alarm control panel.

C. Heat Tracing in Water-Based Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for heat tracing specified in water-based fire-suppression systems. Comply with requirements in Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Equipment and Systems to Be Tested:

a. Self-regulating, parallel-resistance heating cables.
b. Heater trace circuit controller.
c. Interface with fire-alarm control panel.

3. Test Purpose:

a. Evaluate response to ambient temperature below freeze-protection set point.
b. Evaluate heating cable fault alarm.

4. Test Conditions:

a. Subject temperature sensor to temperature approximately [**3 deg F (2 deg C)**]<**Insert value**> above freeze-protection set point (initial set point [**41 deg F (5 deg C)**]<**Insert value**>). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is energized.
b. Subject temperature sensor to temperature approximately [**3 deg F (2 deg C)**]<**Insert value**> below freeze-protection set point (initial set point [**41 deg F (5 deg C)**]<**Insert value**>). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is de-energized.
c. Simulate an electrical fault on the heating cable.

5. Acceptance Criteria:

a. Freeze-protection circuit is energized at set-point temperature of minus **2 deg F (1 deg C)**.
b. Freeze-protection circuit is de-energized at set-point temperature of plus **2 deg F (1 deg C)**.
c. Heater trace circuit controller initiates an alarm of cable fault. Alarm is correctly reported at the fire-alarm control panel.

3.7 Cx TESTS FOR DRY-PIPE SPRINKLER PIPING, FITTINGS, SPRINKLERS, AND SPECIALTIES

A. Air Compressor Run Time:

1. Prerequisites: Acceptance of results of construction checklists specified in Section 211316 "Dry-Piping Sprinkler Systems."
2. Systems and Equipment to Be Tested:

    a. Air compressors in fire-suppression systems.
    b. Associated compressed air piping, valves, and appurtenances.
    c. Associated air pressure controllers.

3. Test Purpose: Evaluate air compressor run time and number of compressor starts.
4. Test Conditions:

    a. Keep compressed air and associated sprinkler piping openings closed during test.
    b. For systems with multiple compressors, lock out compressor motors on all but one compressor. Repeat test for each compressor in turn.
    c. Record number of air compressor motor starts during a 14-day period.
    d. Record air compressor motor run time during the same 14-day period.

5. Acceptance Criteria:

    a. Number of compressor motor starts during test period shall not exceed [**20**]<**Insert number**>.
    b. Compressor motor run time during test period shall not exceed [**60 minutes**]<**Insert time**>.

3.8 Cx TESTS FOR CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

A. Carbon-Dioxide Concentration in Carbon-Dioxide Fire-Extinguishing System:

1. Prerequisites:

    a. Acceptance of results of construction checklists specified in Section 212113.13 "High-Pressure, Carbon-Dioxide Fire-Extinguishing Systems."
    b. Acceptance of results of construction checklists specified in Section 212113.16 "Low-Pressure, Carbon-Dioxide Fire-Extinguishing Systems."
    c. Acceptance of construction checklists specified in Division 23 for systems and equipment serving the protected space.
    d. Partitions, ceilings, doors, and other openings complete in the vicinity of the protected space.

2. Systems and Equipment to Be Tested:

    a. High-pressure, carbon-dioxide fire-extinguishing systems.
    b. Low-pressure, carbon-dioxide fire-extinguishing systems.
    c. Protected space enclosure.
    d. HVAC system protected space isolation equipment.

3. Test Purpose: Evaluate initial and final carbon-dioxide concentration in the protected space following carbon-dioxide release.
4. Test Conditions:

a. HVAC systems operating in normal, occupied, automatic control.
b. Fire-detection and -alarm systems operating in normal, occupied, automatic control.
c. Carbon-dioxide fire-extinguishing system charged and operating in normal, occupied, automatic control.
d. Protected space air temperature is **70 deg F (21 deg C)**.
e. Create a fire-alarm event in the carbon-dioxide protected space, resulting in discharge of carbon-dioxide fire-extinguishing system.
f. Measure and record carbon-dioxide concentration at [**four**]<**Insert number**> locations selected by the CxA when the carbon dioxide is completely dispersed and at the end of holding time.

5. Acceptance Criteria: Carbon-dioxide concentration is no less than [**34**]<**Insert number**> percent concentration by volume at **70 deg F (21 deg C)**.

B. Clean-Agent Concentration in Clean-Agent Fire-Extinguishing System:

1. Prerequisites:

a. Acceptance of results of construction checklists for Section 212200 "Clean-Agent Fire-Extinguishing Systems."
b. Acceptance of construction checklists specified in Division 23 for systems and equipment serving the protected space.
c. Partitions, ceilings, doors, and other openings complete in the vicinity of the protected space.

2. Systems and Equipment to Be Tested:

a. Clean-agent fire-extinguishing systems.
b. HVAC system protected space isolation equipment.
c. Protected space enclosure.

3. Test Purpose: Evaluate initial and final clean-agent concentration in the protected space following carbon-dioxide release.
4. Test Conditions:

a. HVAC systems operating in normal, occupied, automatic control.
b. Fire-detection and -alarm systems operating in normal, occupied, automatic control.
c. Clean-agent fire-extinguishing system charged and operating in normal, occupied, automatic control.
d. Protected space air temperature is **70 deg F (21 deg C)**.
e. Create a fire-alarm event in the clean-agent protected space, resulting in discharge of clean-agent fire-extinguishing system.
f. Measure and record clean-agent concentration at [**four**]<**Insert number**> locations selected by the CxA when the clean agent is completely dispersed and at the end of holding time.

5. Acceptance Criteria: Clean-agent concentration is no less than [**34**]<**Insert number**> percent concentration by volume at **70 deg F (21 deg C)**.

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Task	Specification	Specification Description
01 00 00 00MOD000	01 00 00 00	General Requirements
01 00 00 00MOD000	26 01 00 00	Supplemental Requirements for Electrical

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Task	Specification	Specification Description
02 41 13 13	02 41 19 00	Selective Demolition

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SECTION 02 41 19 00 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Demolition and removal of selected portions of exterior or interior of building or structure and site elements.
2. Removal and salvage of existing items for delivery to Owner and removal of existing items for reinstallation.

B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
3. Section 017300 "Execution" for cutting and patching procedures.
4. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
5. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.
6. Section 330500 "Common Work Results for Utilities" for removal of site utility systems piping, equipment, and components.

1.2 DEFINITIONS

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

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage; prepare for reuse; and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed.

1.3 MATERIALS OWNERSHIP

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

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

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

1.4 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.5 PREINSTALLATION MEETINGS

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

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.
6. Review and finalize protection requirements.
7. Review procedures for [**noise control**][**and**][**dust control**].
8. Review storage, protection, and accounting for items to be removed for salvage or reinstallation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For refrigerant recovery technician.

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

C. Survey of Existing Conditions: Submit survey.

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

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

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Temporary interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

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

G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

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

1.8 QUALITY ASSURANCE

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

1.9 FIELD CONDITIONS

A. Owner will [**not**]occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

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

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials:

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

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

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

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

E. Historic Areas: Demolition and hauling equipment and other materials to be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by [**12 inches**] or more.

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

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

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

C. Sustainable Design Requirements for Building Reuse:

1. Maintain the existing building structure, envelope, and interior nonstructural elements of an abandoned or blighted building. Do not demolish such existing construction beyond indicated limits.
2. Maintain the existing building structural systems where indicated to remain. Do not demolish such existing construction beyond indicated limits.
3. Maintain the existing interior ceilings, interior partitions, and/or demountable walls where indicated to remain. Do not demolish such existing construction beyond indicated limits.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

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

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

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

1. Inventory and record the condition of items to be removed for salvage or reinstallation. Photograph or video conditions that might be misconstrued as damage caused by removal.

2. Photograph or video existing conditions of adjoining construction including finish surfaces, that might be misconstrued as damage caused by selective demolition operations or removal of items for salvage or reinstallation.

3.2 PREPARATION

A. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

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

B. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location[**and cleaned**] and reinstalled in their original locations after selective demolition operations are complete.

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

3.3 UTILITY SERVICES AND BUILDING SYSTEMS

A. Existing Services/Systems to Remain: Maintain utilities and building systems and equipment to remain and protect against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utilities and building systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If disconnection of utilities and building systems will affect adjacent occupied parts of the building, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to those parts of the building.
4. Demolish and remove existing building systems, equipment, and components indicated on Drawings to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug

remaining piping with same or compatible piping material.
b. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
c. Equipment to Be Removed: Disconnect and cap services and remove equipment and components.

5. Abandon existing building systems, equipment, and components indicated on Drawings to be abandoned in place.

a. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
b. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

6. Remove and reinstall/salvage existing building systems, equipment, and components indicated on drawings to be removed and reinstalled or removed and salvaged:

a. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment and components; when appropriate, reinstall, reconnect, and make equipment operational.
b. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and components and deliver to Owner.

3.4 SALVAGE/REINSTALL

A. Removed and Salvaged Items:

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

B. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

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

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" to mean historic "removal" or "dismantling" as specified in Section 024296 "Historic Removal and Dismantling."

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete:

1. Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least **3/4 inch** at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
2. Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

D. Resilient Floor Coverings: Remove floor coverings and adhesive in accordance with recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."[**Do not use methods requiring solvent-based adhesive strippers.**]

E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so

that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site [**and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.**][**and recycle or dispose of them in accordance with Section 017419 "Construction Waste Management and Disposal."**]

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19 00

SECTION 02 41 19 13 - CUTTING AND PATCHING

1.1 GENERAL

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

B. Summary
1. This Section includes procedural requirements for cutting and patching.

C. Definitions
1. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
2. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

D. Submittals
1. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   a. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   b. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   c. Products: List products to be used and firms or entities that will perform the Work.
   d. Dates: Indicate when cutting and patching will be performed.
   e. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   f. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
   g. the Owner's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

E. Quality Assurance
1. LEED Requirements for Building Reuse:
   a. Credit MR 1.1 and 1.2, **as directed**: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   b. Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   c. Credit MR 1.2 and 1.3, **as directed**: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be removed; do not cut such existing construction beyond indicated limits.

2. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
   a. **Refer to the Owner for list of elements that might otherwise be overlooked as structural elements and that require Architect's or Construction Manager's approval of a cutting and patching proposal**.
3. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
   a. Primary operational systems and equipment.
   b. Air or smoke barriers.
   c. Fire-suppression systems.
   d. Mechanical systems piping and ducts.
   e. Control systems.
   f. Communication systems.
   g. Conveying systems.
   h. Electrical wiring systems.
   i. Operating systems of special construction in Division 13.
4. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
   a. Water, moisture, or vapor barriers.
   b. Membranes and flashings.
   c. Exterior curtain-wall construction.
   d. Equipment supports.
   e. Piping, ductwork, vessels, and equipment.
   f. Noise- and vibration-control elements and systems.
5. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
6. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

F. Warranty
1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

1.2 PRODUCTS

A. Materials
1. General: Comply with requirements specified in other Sections.
2. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   a. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

1.3 EXECUTION

A. Preparation
1. Temporary Support: Provide temporary support of Work to be cut.
2. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
3. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
4. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize **OR** prevent, **as directed**, interruption to occupied areas.

B. Performance
1. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   a. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   a. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   b. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   c. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   d. Excavating and Backfilling: Comply with requirements in applicable Division 31 where required by cutting and patching operations.
   e. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   f. Proceed with patching after construction operations requiring cutting are complete.
3. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
   a. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   b. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
      1) Clean piping, conduit, and similar features before applying paint or other finishing materials.
      2) Restore damaged pipe covering to its original condition.
   c. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      1) Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

d. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
e. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

4. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 02 41 19 13

Task	Specification	Specification Description
02 41 19 13	02 41 19 00	Selective Demolition

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SECTION 02 61 00 00 - REMOVAL AND DISPOSAL OF CONTAMINATED SOILS

1.1 GENERAL

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

B. Definition
1. Hazardous materials shall be defined as asbestos containing materials, lead-based paint, PCBs, bird waste, and other materials categorized as hazardous by the EPA.

C. Submittals
1. Before start of work: At the pre-construction meeting, the Contractor shall submit the following to the Owner's Representative for review. Do not start work until these submittal are returned with Owner's Representative stamp indicating that the submittal is returned for unrestricted use.
   a. Copy of State or local license for hazardous waste hauler.
   b. Certificate of at least one on-site supervisor which has satisfactorily completed the OSHA 40 hour Health and Safety course for handling hazardous materials.
   c. Certificates of workers which have successfully completed the OSHA 40-Hour Health and Safety Course for Hazardous Materials.
   d. List of the employees scheduled to perform this work.
   e. Schedule of start and finish times and dates for this work.
   f. Name and address of landfill where these waste materials are to be deposited. Include contact person and telephone number.
   g. Safety Data Sheet (SDS) for all materials to be removed.
   h. If contractor introduces any chemical into the work environment, a SDS for that chemical must be presented to the Owner's Representative prior to use.
   i. Transporter must have notified the EPA and/or other appropriate local government agency in advance of its intentions to transport hazardous materials and, if applicable, receive an identification number.
   j. Contingency Plan for handling emergencies with spills or leaks.
   k. Certificates of workers which have successfully completed the OSHA 24-Hour Health and Safety Course for Hazardous Materials.

1.2 PRODUCTS

A. Materials
1. Drums: Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA, EPA (40 CFR Parts 264-264 and 300), and DOT Regulations (49 CFR Parts 171-178). Use of damaged containers shall not be allowed.
2. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
3. Absorbent Material: Clay, soil or any commercially available absorbent used for the purpose of absorbing hazardous or potentially hazardous materials.

1.3 EXECUTION

A. All waste shall be transported and disposed of in accordance with all federal, state and local guidelines and regulations. The contractor is to obtain all permits, licenses, etc., which are necessary for the transporting and disposal of hazardous waste.

B. Waste haulers shall maintain waste manifest and shipment record forms.

END OF SECTION 02 61 00 00

Task	Specification	Specification Description
02 61 26 00	02 61 00 00	Removal and Disposal of Contaminated Soils
02 61 26 00	02 82 33 00	Removal Of Friable Asbestos-Containing Materials

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SECTION 02 82 16 00 - ENGINEERING CONTROL OF ASBESTOS CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for encapsulation (lock-down) of asbestos-containing materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: Manufacturers technical information including label analysis and application instructions for each material proposed for use.
2. Installation Instructions: Manufacturer's installation instructions with specific project requirements noted.
3. Performance Warrantee: Manufacturers performance guarantee.
4. Safety Data Sheet: Safety Data Sheet in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

C. Delivery And Storage: Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
1. Name or title of material
2. Manufacturer's stock number and date of manufacture
3. Manufacturer's name
4. Thinning instructions
5. Application instructions
6. Deliver materials together with a copy of the OSHA Material
7. Safety Data Sheet for the material.

D. Job Conditions: Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.

E. Quality Assurance
1. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 “Standard Practice for Encapsulants for Spray-or-Trowel-Applied Friable Asbestos- Containing Building Materials."

F. Warranty
1. Performance Warranty: Contractor shall submit written Performance Warranty, executed by the contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, unforeseeable ambient exposures or other causes beyond anticipated conditions and contractors control. Warranty period shall be for at least one year after date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Encapsulant system shall be an acrylic, elastomeric type, spray, brush or roller-applied, tinted penetrating or tinted bridging type, specifically designed for application to asbestos-containing material. System shall be equal to Global Encasement System as manufactured by GLOBAL

Encasement Inc., 132-32nd Street, Union City, NJ 07087 U.S.A., Tel. (800) 266-3982/(201) 902-9770.

a. All encasement topcoat materials shall be warranted to be heavy-bodied, from the same manufacturer, and shall be long lasting, highly-pure (low VOC) materials that remain flexible, chalk resistant and resist cracking, peeling, algae and fungus that can cause future indoor air quality concerns.
b. To allow for building movement without cracking or disturbing fibrous materials, coating systems shall have passed testing to ASTM standards for adhesion, permeability, aged flexibility and with aged elasticity for the encasement system of over 250%.
c. Coatings shall be Class A Fire Rated, water-based, non-toxic, safe and easy to use, contain no hazardous ingredients by OSHA definition, comply with all known building codes and be non-flammable.
d. Coating materials shall have low VOC (Volatile Organic Compound) content.
e. Coating materials shall not release health threatening toxic smoke and fumes in a fire and shall comply with all known building codes.
f. Coating materials shall have passed the following testing standards:
    1) ASTM E 119 fire tests demonstrating that applying a multi-layer system over fireproofing does not adversely affect the fireproof rating of the fireproofing (3 hour test).
    2) UPITT Combustion Toxicity Test proving nothing toxic is released in a fire.
    3) ASTM E 84 and E162 fire tests for "Class A" - Surface Flammability and Burning Characteristics (Flame Spread = 0, Smoke Developed = 5).
    4) "Pull-off Adhesion" test per ASTM E736 equals or exceeds 9,950 lbs./sq. ft. (89.1 lbs./sq. in.).
    5) ASTM D 1653 and E96 "Water Vapor Permeability" (showing the rate that water vapor can pass through the system).
    6) Impact Resistance, "Tensile Strength" shall exceed 150 psi; "Elongation" shall exceed 250%.
    7) System shall be mildew resistant, impact resistant, scrub resistant, non-yellowing, non-chalking, highly blister resistant, rust resistant, highly chemical resistant and shall remain flexible after 1000 hour ASTM Accelerated Weather testing.
    8) Water-Based materials (low VOC) Volatile Organic Content of Primer-Sealer-Neutralizer = 0.1 g/L (0.001 lb./gal.) and Encasement Top Coat = 0.1 g/L (0.001 lb./gal.) as tested by EPA Method 24.
    9) Materials comply with applicable standards for installation on interior and/or exterior surfaces of a building.
    10) Encasement Systems shall provide additional water-proofing protection.

B. Related Materials:
    1. Elastomeric architectural sealants, caulking compounds, primers, and similar materials shall be approved by the manufacturer of the encasement coatings. All materials used shall be applied in accordance with its manufacturer's recommendations.

C. Applicable Standards
    1. Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E 1494.

1.3 EXECUTION

A. General
    1. Prior to applying any encapsulating material in Work Areas, Contractor shall obtain final visual inspection approval by the Project Administrator.
    2. Prior to applying any encapsulating material, Contractor shall ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or

separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.

3. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.

B. Worker Protection
   1. Before beginning work with any material for which a Safety Data Sheet has been submitted provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

C. Application
   1. Comply with all manufacturer's instructions for particular conditions of installation. Consult with manufacturer's technical representative for conditions not covered.
   2. Encapsulate all surfaces in full compliance with manufacturer's procedures.
   3. At completion of Encapsulation and before removal of Work Area enclosures and Pressure Differential System, decontaminate space in accordance with requirements of manufacturer’s instructions.
   4. Remove all debris from the project site and restore area to proper conditions by cleaning all surfaces in accordance with manufacturer’s written recommendations.
   5. At completion of work submit manufacturer’s record of inspection of completed work and Manufacturers Performance Guarantee executed by both manufacturer and Contractor.

END OF SECTION 02 82 16 00

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SECTION 02 82 33 00 - REMOVAL OF FRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

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

B. Description
1. Furnish all labor, materials, facilities, equipment, services, employee training and testing, permits and agreements necessary to perform the work required for asbestos removal, encapsulation, repair, clean-up, decontamination, re-insulation and all other work in accordance with these specifications, in accordance with the latest regulations from the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the recommendations of National Institute of Occupational Safety and Health (NIOSH), and any other applicable federal, state and local government regulations. Whenever there is a conflict or overlap of the above references, the most stringent provision is applicable.
2. The work specified herein shall be performed by competent persons trained, knowledgeable and qualified in the state-of-the-art techniques of asbestos abatement, handling and subsequent cleaning of contaminated areas.

C. Scope
1. The quantities of materials and limits of abatement work area(s) shall be verified by the asbestos contractor.

D. Asbestos Hazard
1. Asbestos-containing material when damaged or disturbed is subject to fiber releases. Wet methods are a primary means of controlling fiber release.
2. Strict compliance with each of the provisions outlined in these specifications for the encapsulation, repair and handling of asbestos-containing material is of great importance, because:
   a. The inhalation of airborne asbestos fibers can cause a very serious and often fatal disease.
   b. Workers may not be aware they are inhaling asbestos fibers.
   c. Symptoms of the disease do not appear for many years.
   d. Only the Contractor and its employees can prevent the inhalation of asbestos fibers, which can lead to the development of asbestos-related disease.
   e. No insurance is available to provide for asbestos-related disease.

E. Other Hazardous Material
1. Contractor shall comply with OSHA 29 CFR 1926.62 - Lead in Construction when demolishing any equipment or architectural component identified as lead-containing or lead-based paint. The work of this project is considered a demolition activity.
2. the Owner anticipates that a substantial amount of the Project will involve lead paint.

F. Qualifications
1. the Owner and the Owner's Representative will verify and approve the experience of the Asbestos Abatement Contractor based upon submission at the time of bidding by Contractor evidence of the following:
   a. Experience: Provide the names and locations of at least three asbestos abatement projects of comparable size and complexity comparable with this work. Provide the names

and telephone numbers of contact person at previous projects. Provide the final air monitoring decontamination fiber levels achieved.

b. Personnel: Provide the name(s) of "Competent Person" as defined by OSHA 29 CFR 1926.32(f) - Asbestos. Demonstrate the education and specialized training with successful completion of examination of an EPA approved course. Provide evidence of participation in five projects of complexity comparable with this project.

c. Licensing and Certification: The Contractor must hold a current, valid asbestos license issued by the State in which the work is to be performed.

G. Notices And Record Keeping

1. Contractor shall maintain for at least 30 years, a record for each asbestos project in which the Contractor engages. Each record shall include the following information: name, address, and social security number of all personnel involved with the project, the name address and social security number of the OSHA "Competent Person" who will supervise the work, the amount of asbestos material that was removed, repaired, encapsulated or disturbed, the commencement and completion date of the work, copies of Hazardous Waste Manifest(s), personal air monitoring results and any other appropriate information.
2. The Contractor shall send written notification as required by USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61, Subpart M) to the Owner, at least 10 working days prior to beginning any work on asbestos-containing materials.
3. Include the following information:
   a. Name and address of the Owner or operator.
   b. Description of the facility being demolished or renovated, including the size, age, and prior use of the facility.
   c. Estimate of the approximate amount of asbestos material present in the facility in terms of linear feet of pipe, and surface area on other facility components. For facilities in which the amount of asbestos materials is less than 260 linear feet on pipes and less than 160 square feet on other facility components, explain techniques of estimation.
   d. Location of the facility being demolished or renovated.
   e. Scheduled starting and completion dates of demolition or renovation.
   f. Nature of planned demolition or renovation and method(s) to be used.
   g. Procedures to be used to comply with the requirements of USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61 Subpart M).
   h. Name and location of the waste disposal site where the asbestos waste material will be deposited.
4. Prior to commencement of work, the Contractor shall submit the following documents to the Owner's Representative. No work will be allowed to start until these documents have been approved:
   a. The schedule of the work, including manpower, length and number of work shifts. Schedule shall be coordinated with the Owner's full occupancy of all areas of the building.
   b. Satisfactory proof that written notification has been provided to the EPA regional office and the Owner.
   c. Proof that all required permits, disposal site locations, and arrangements for transportation and disposal of asbestos-contaminated materials, supplies and the like have been obtained.
   d. Complete a worker certificate indicating that all employees have had instruction and training on the hazards of asbestos exposure, the use and fitting of respirators, protective dress, wet and dry decontamination procedures, entry and exit from work areas, and all aspects of work procedures and protective measures.
   e. Documentation indicating that all employees have received appropriate medical examinations and have successfully passed fit testing for the respirator to be worn. As a

minimum, medical exams must be consistent with OSHA 29 CFR 1926.1101(K)(9)(viii)(G)-Asbestos Regulation.

f. Samples of signs to be used in and around the work area to comply with 0SHA 29 CFR 1926.1101(K)(9)(viii)(I)- Asbestos regulations and as required by federal, state and municipal regulations.

g. Safety Data Sheets (OSHA form 174 or equivalent) for all chemicals used during work performed under this section.

h. Encapsulation data and encapsulation procedures.

i. Design of pressure differential system including calculation used to arrive at the number of machines necessary to achieve one air change per every 10 minutes.

j. Location of personnel and material decontamination units for each work area.

5. Contractor shall provide written notification to the Owner's Representative of its intent to start work at least five days in advance. In no case will the Contractor start work until authorization to proceed is given.

6. During the work, Contractor shall maintain a daily log which will be kept at the job site. Items to be included in the daily log shall include but are not limited to the following:

a. Meetings, purpose, attendees, discussions, items of resolution.

b. Visitations, authorized and unauthorized.

c. Sign-in sheets of all personnel entering and leaving the work area.

d. Special or unusual events (i.e., barrier breeching equipment failures).

e. Personal air monitoring results.

f. Two copies of the daily log are required for Project Closeout.

H. Terminology (Definitions)

1. Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, enclosure or encapsulation.

2. Air Lock - A system for permitting ingress or egress without permitting air movement between any two adjacent areas consisting of two curtained doorways. The air lock must be maintained in an uncontaminated condition at all times.

3. Air Monitoring; - The process of measuring the asbestos fiber content of a specific volume of air in a stated period of time using methods approved or recommended by OSHA, EPA, NIOSH or other method approved by the Owner or the Owner's Representative.

4. Amended water - Water to which a surfactant has been added.

5. Asbestos - A generic name given to a number of naturally occurring hydrated mineral silicates that possess a unique crystalline structure, are incombustible in air, and are separable into fibers. Asbestos includes the asbestiform varieties of Chrysotile (serpentine), Crocidolite (Riebeckite), Amosite (Cummingtonite-Grunente), Anthophyllite, Actinolite, and Tremolite.

6. Asbestos-containing. material (ACM) - Any material that contains more than 1 percent asbestos by weight as determined by Polarized Light Microscopy (PLM).

7. Authorized Visitor - the Owner or its designated representative, or a representative of any regulatory or other agency having jurisdiction over the project.

8. Class I - Asbestos work means activities involving the removal of thermal systems insulation (TSI) and surfacing ACM and PACM.

9. Class II - Asbestos work means activities involving the removal of ACM which is not TSI or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.

10. Class III - Asbestos work means repair and maintenance operations where "ACM" including TSI and surfacing ACM and PACM is likely to be disturbed.

11. Class IV - Asbestos work means maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean-up dust, waste and debris resulting from Class I, II and III activities.

12. Critical Barrier - A unit of temporary construction which provides the only separation between an asbestos work area and an adjacent, potentially occupied, space. The critical barrier is composed of at least one intact sheet of polyethylene sheeting.

13. Decontamination Enclosure System - A series of connected rooms with curtained doorways between any two adjacent rooms, for the decontamination of workers or of materials and equipment. A decontamination system contains at least two air locks.
14. Disposal - All procedures necessary to transport and deposit the asbestos-contaminated material stripped and removed from the building in a waste disposal site in compliance with applicable federal, state, and local regulations.
15. Disposal Site - A site approved by the EPA for the disposal of asbestos-containing wastes.
16. Encapsulant - A liquid which can be applied to asbestos-containing materials and which controls the possible release of fibers from the materials.
17. Encapsulation - The use of an agent to seal the surface (bridging encapsulant) or penetrate the bulk (penetrating encapsulant) of the asbestos-containing material.
18. HEPA -High Efficiency Particulate Air - A type of filter which is 99.97% efficient at filtering particles of 0.3 micrometers in diameter.
19. HEPA Vacuum Equipment - Vacuuming equipment equipped with a HEPA filter in the exhaust outlet, and so designed and maintained that 99.97% of all particles of 0.3 micrometer in diameter in the inlet air are collected and retained.
20. Negative Pressure Respirators - Respirators which function by the wearer breathing in air through a filter.
21. NIOSH - National Institute of Occupational Safety and Heath.
22. the Owner's Representative - Authorized Consultants
23. Permissible Exposure Level (PEL) - A level of airborne fibers specified by OSHA as an occupational exposure standard for asbestos. It is 0.1 f/cc of air, eight-hour TWA, as measured by Phase Contrast Microscopy.
24. Repair - The restoration of damaged or deteriorated asbestos-containing material to intact condition.
25. Respirator Protection Program - A set of procedures and equipment required by OSHA if employees wear negative pressure respirators or if fiber levels are above the PEL.
26. Surfactant - Chemical wetting agent added to water to improve penetration, thus reducing the amount of water required for a given operation or area, and enhancing the effect of the water in reducing fiber release.
27. Thermal Systems Insulation - Material applied to pipes, fittings, boilers, breeching, tanks, ducts or other interior structural components to prevent heat loss or gain, or water condensation, or for other purposes.
28. Wet Cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths and mops or other cleaning tools that have been dampened with clean water and afterwards disposing of these cleaning tools as asbestos-contaminated waste.

I. Permits And Licenses:
1. The Contractor must maintain current licenses as required by applicable state or local jurisdictions for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

J. Regulations
1. This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specifications. This section also sets forth those notices and permits which are known to the Owner and which either must be applied for and received, or which must be given to governmental agencies before start of work.
2. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.
3. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor

is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state, and local regulations. The Contractor shall hold the Owner and the Owner's Representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of itself, its employees, or its Sub-Contractors.

4. Federal requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following regulations:
   a. U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:
      1) U.S. Department of Labor, OSHA, including, but not limited to:
         a) Occupational Exposure to Asbestos, Tremolite, Anthophyllite and Actinolite; Final Rules
            Title 29, Part 1910, Section 1001
            Part 1926, Section 1101 of the Code of Federal Regulations
         b) Respiratory Protection
            Title 29, Part 1910, Section 134 of the Code of Federal Regulations
         c) Construction Industry
            Title 29, Part 1926.1011, of the Code of Federal Regulation
         d) Access to Employee Exposure and Medical Records
            Title 29, Part 1910, Section 2 of the Code of Federal Regulations
         e) Hazard Communication
            Title 29, Part 1910, Section 1200 of the Code of Federal Regulations
         f) Specifications for Accident Prevention Signs and Tags
            Title 29, Part 1910, Section 145 of the Code of Federal Regulations
      2) U.S. Environmental Protection Agency (EPA) including, but not limited to:
         a) Asbestos Abatement Projects Rule
            40 CFR Part 762
            CPTS 62044, FRL 2843-9
            Federal Register, Vol. 50 No. 134, July 12,1985
            P28530-28540
         b) Regulation for Asbestos
            Title 40, Part 61, Subpart A of the Code of Federal Regulations
         c) National Emission Standard for Asbestos
            Title 40, Part 61, Subpart M (Revised Subpart B) of the Code of Federal Regulations
      3) State requirements which govern asbestos abatement work and/or hauling and disposal of asbestos waste materials.
      4) Contractor shall abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials including the following:
         a) American National Standards Institute (ANSI)
            1430 Broadway
            New York, NY 10018
            (212) 354-3300
         b) Fundamentals Governing the Design and Operation of Local Exhaust Systems Publication Z9.2-79
         c) Practices for Respiratory Protection Publication Z288.2-80
         d) American Society for Testing and Materials (ASTM)
            1916 Race Street
            Philadelphia, PA 19103
            (215) 299-5400
         e) Specification for Encapsulants for Friable Asbestos-Containing Building Materials
         f) Safety and Health Requirements Relating to Occupational Exposure to Asbestos

K. the Owner's Representative
   1. the Owner's Representative is authorized by the Owner to perform the following:
      a. Have free access to all asbestos work areas.
      b. To assist in interpretation of procedures.
      c. To advise on all provisions of the contract documents pertaining to the control of asbestos.
      d. To stop work if, in the course of performing their monitoring duties, an instance of substantial nonconformance with the contract documents is observed.
      e. To stop work if a situation presenting a health hazard to workers or the Owner's employees or occupants of the building is observed.
      f. To act as the Owner's liaison in technical matters involving the asbestos-related work.
      g. To perform air sampling inside and outside the asbestos work area during the project. The Contractor shall cooperate fully with the Owner's Representative, its agents and employees, and ensure cooperation of its workers during collection of air samples and work area inspections.
      h. the Owner's Representative role in advising the Owner on environmental health matters does not relieve the Contractor's obligation to comply with all applicable health and safety regulations. Air monitoring results generated by the Owner's Representative shall not be used by the Contractor to represent compliance with regulatory agency requirements for monitoring of worker's exposure to airborne asbestos, nor shall any other activity on the part of the Owner's Representative represent the Contractor's compliance with applicable health and safety regulations.

L. Pre-Construction Conference
   1. An initial progress meeting recognized as "Pre-Construction Conference" shall be held prior to start of any work. Contractor shall meet at project site, with General Superintendent, the Owner, the Owner's Representative, and other entities concerned with asbestos abatement work. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to all participants prior to convening Pre-Construction Conference.
   2. This is an organizational meeting, to review responsibilities and personnel assignments, to locate the containment and decontamination areas; and temporary facilities including power, light, water, etc.
   3. Submit waivers on forms, and executed in a manner acceptable to the Owner. Administrative requirements that must proceed or coincide with Contractor's submittal for final payment shall consist of the following:
      a. Completion of project closeout requirements.
      b. Completion of items specified for completion beyond time of Final Completion (regardless of whether special payment application was previously made).
      c. Assurance, satisfactory to the Owner, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
      d. Transmittal of required project construction records to the Owner.
      e. Landfill receipts for all asbestos-containing material.
      f. Proof, satisfactory to the Owner, that taxes, fees and similar obligations of Contractor have been paid.
      g. Removal of temporary facilities, services, surplus materials, rubbish and similar elements.
      h. Consent of surety for final payment.

M. Project Closeout
   1. Project closeout is the term used to describe certain collective project requirements that indicate completion of the work to be fulfilled near the end of the contract time. Also, in preparation for final acceptance of the work by the Owner, as well as, final payment to the Contractor and the normal termination of the Contract.
   2. Include supporting documentation for completion as indicated in these contract documents.
   3. Submit a statement on accounting of changes to the Contract Sum.
   4. Advise the Owner of pending insurance change-over requirements.

5. Submit specific warranties, workmanship and maintenance bonds, maintenance agreements, final certifications and similar documents.
6. Obtain and submit releases enabling the Owner's full, unrestricted use of the work area and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.
7. Results of the completed inspection will form the initial "punch-list" for final acceptance.
8. A complete record, certified by the testing laboratory, of all personal air monitoring results.
9. Complete the following cleaning operations as outlined in Paragraph “Decontamination Procedures” before requesting the Owner's Representative inspection for certification of Final Completion.
    a. Remove exposed labels in finished spaces which are not required as permanent labels on materials supplied as part of the work, except for "Asbestos", "Asbestos Free", or Thermal Insulation Labels specified elsewhere.
    b. Clean transparent materials, affected by the work including mirrors and window/door glass, to a polished condition, removing substances which are noticeably vision-obscuring materials. Replace broken glass and damaged transparent materials.
    c. Clean exposed hard-surfaced finishes affected by the work, to a dirt-free condition, free of dust, stains, films and similar distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition.
    d. Clean plumbing fixtures affected by the work to a sanitary condition, free of stains including those resulting from water exposure.
    e. Replace all HVAC filters using materials supplied by the Owner or clean non-replaceable filters after minimum of two days of operation of HVAC equipment.
    f. Clean light fixtures and lamps, which have been affected by the work so as to function with full efficiency. Replace lamps where inoperable.
    g. Repair any damage to wall, ceiling and floor surfaces caused by installation and removal of the polyethylene sheeting.

N. Personnel Protection
1. Prior to commencement of work, the workers shall be instructed and be knowledgeable in the areas described in Paragraph "Submittals and Notices" having to do with employees.
2. Worker Protection - shall comply with 29 CFR 1910.134 (Respiratory Protection).
    a. Because there is no known safe level of exposure to asbestos, it is prudent to reduce worker's exposures to as low a level as possible. Proper respiratory protection is critical in minimizing exposure.
    b. Workers shall be provided, as a minimum, with personally issued and marked respirators equipped with high efficiency particulate filters approved by NIOSH to be worn in the designated work area and/or whenever a potential exposure to asbestos exists. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
    c. No worker shall be exposed to levels greater than 0.01 f/cc as determined by the protection factor of the respirator worn and the work area fiber levels.
    d. Whenever powered purifying respirator protection is used, a sufficient supply of replacement batteries and HEPA filter cartridges shall be provided to the workers.
    e. Air monitoring required by OSHA is work of the Contractor and not covered in this specification. Contractor shall post, on a daily basis, results of the air monitoring results from the previous shift. A complete record, certified by the testing laboratory, of all personal air monitoring tests and results will be furnished to the Owner and the Owner's Representative prior to Contractor's Request for Final Payment.
    f. During encapsulation operations or usage of other organic base aerosols (e.g., spray glue, expanding foam), workers shall be provided with combination cartridges consisting of organic vapor and HEPA sections.

g. Workers shall be provided with sufficient sets of protective full-body clothing to be worn in the designated work area and/or whenever potential exposure to asbestos exists. Such clothing shall include, but not be limited to, full-body coveralls, headgear and gloves. Workers shall assure that hoods covering their hair are worn in the designated work areas at all times. Eye protection and hard hats shall be provided as required by applicable safety regulations. Eye protection shall be worn during encapsulation operations. Non-disposable type protective clothing and footwear shall be left in the work area until the end of the asbestos abatement work, at which time such items will be disposed of as asbestos waste.

h. Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent body contamination.

i. Protective clothing shall not be worn in lieu of street clothing outside the work area.

j. Visitor Clothing: The Contractor shall provide authorized visitors with suitable respirator, protective clothing, headgear, eye protection, and footwear as described herein, whenever they enter the work area.

3. Decontamination and Work Procedures: The decontamination and work procedures to be followed by workers shall be posted as described in these specifications.

4. Worker and Authorized Visitor Protection Procedures:

a. Each worker and authorized visitor shall, upon entering the job site, remove street clothes in a designated clean change area and put on a respirator with new filters and clean protective clothing before entering the work area.

b. The Contractor's employees shall perform a positive/negative respirator fit test each time it enters the work area. If leakage occurs, the respirator must be re-adjusted or replaced.

c. Workers shall maintain their respirators in a safe operating condition. The condition of respirators shall be checked daily.

d. Workers and visitors shall complete the decontamination procedures as outlined in the specification upon exiting the work area.

e. Workers shall not eat, drink, smoke, or chew gum or tobacco in or near the asbestos work areas.

f. Workers shall be fully protected with respirators and protective clothing immediately prior to the first disturbance of asbestos-containing or contaminated materials and until final cleanup is completed.

O. Air Monitoring

1. The airborne fiber counts outside the work area will be monitored to detect faults in the work area isolation such as contamination of the building outside of the work areas with airborne asbestos fibers, failure of filtration or rupture in the negative pressure system.
Should any of the above occur, the Contractor shall immediately cease asbestos abatement activities until the fault is corrected. Work shall not recommence until authorized by the Owner's Representative. In the case of mini-enclosures the Owner's Representative will monitor air in a remote location of the residence to determine the baseline of asbestos.

2. The airborne fiber counts in the work area will be monitored. The purpose of this air monitoring will be to detect airborne fiber counts which may significantly challenge the ability of the work area isolation procedures to protect the balance of the building or outside of the building from contamination by airborne fibers. In the case of mini-enclosures the Owner's representative may monitor air outside of several enclosures if they are in close proximity.

3. Contractor shall maintain an average airborne count inside the work area of less than 0.5 f/cc. If the fiber counts rise above this figure for any sample taken, revise work procedures to lower fiber counts. If the TWA fiber count for any work shift or eight-hour period exceeds 0.5 f/cc, stop all work, leave pressure differential system in operation and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

4. If airborne fiber counts exceed 1.0 f/cc for any period of time cease all work until fiber counts fall below 0.5 f/cc and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

5. If any air sample taken outside of the work area exceeds the 0.01 f/cc of air, Contractor shall immediately and automatically stop all work. If this air sample was taken inside the building and outside of critical barriers around the work area, immediately erect new critical barriers to isolate the affected area from the balance of the building. Erect Critical Barriers at the next existing structural isolation of the involved space (e.g., wall, ceiling, and floor). Leave Critical Barriers in place until completion of work and insure that the operation of the negative pressure system in the work area results in a flow of air from the balance of the building into the affected area.
6. If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a temporary decontamination facility consisting of a shower room and changing room. After cleaning and decontamination of the affected area remove the shower room and leave the changing room in place as an air lock.
7. After certification of visual inspection in the work area, remove critical barriers separating the work area from the affected area. Final air samples will be taken within the entire area.
8. The following procedure will be used to resolve any disputes regarding fiber types when a project has been stopped due to excessive airborne fiber counts. "Airborne Fibers" referred to above include all fibers regardless of composition as counted in the Phase Contrast Microscopy (PCM) NIOSH 7400 Method procedures. If work has stopped due to high airborne fiber counts, air samples will be secured in the same area by the Owner's Representative for analysis by electron microscopy. "Airborne fibers" counted in samples analyzed by Scanning or Transmission Electron Microscopy (TEM) shall be only asbestos fibers, but of any diameter and length. Subsequent to analysis by Electron Microscopy the number of airborne fibers shall be determined by multiplying the number of fibers, regardless of composition, counted by the PCM NIOSH 7400 Method procedure by a number equal to asbestos fibers counted divided by all fibers counted in the electron microscopy analysis.
9. If electron microscopy is used to arrive at the basis for determining airborne fiber counts in accordance with the above paragraph, and if the average of airborne asbestos fibers in all samples taken exceeds 0.1 f/cc, or if any one sample exceeds 0.2 f/cc, then the cost of such analysis will be born by the Contractor, at no additional cost to the Owner.
10. the Owner's Representative will secure at least the following air samples to establish a base line before start of work involving large enclosures:

Location Sampled	**Number of Samples**	**Analysis Method**	**Detection Limit f/cc**	**Minimum Volume Liters**	**Rate LPM**
Each Work Area	1	PCM	0.01	1,900	2-16
Outside Each Work Area	1-3	PCM	0.01	1,900	2-16

11. Base Line is an action level expressed in f/cc, which is ten percent greater than the largest of the following:
    a. Average of the samples collected on cellulose ester filters outside each work area.
    b. Average of the samples collected on cellulose ester filters outside the building.
    c. 0.01 fibers per cubic centimeter.
12. Daily: From start of work of Paragraph "Temporary Enclosure" through the work of Paragraph "Project Decontamination," the Owner may be taking the following samples on a daily basis. The location of each air sample will be determined by the Owner's Representative.
    a. Baseline
    b. Work Area
13. For larger enclosures samples will be collected on 25 mm cassettes with the following filter medial:
    PCM: 0.8 micrometer mixed cellulose ester.

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM

Each Work Area	2	PCM	0.01	1,900 as required by conditions	2-16
Outside Each Work Area Critical Barrier	1	PCM	0.01	1,900	2-16
Clean Room	1	PCM	0.01	1,900	2-16
Equip Decon	1	PCM	0.01	1,900	2-16

14. Additional samples may be taken at the Owner or the Owner's Representative discretion. If airborne fiber counts exceed allowed limits, additional samples will be taken as necessary to monitor fiber levels.
15. The services of a testing laboratory will be employed by the Owner to perform laboratory analysis of the air samples. Samples will be sent daily so that verbal reports on air samples can be obtained in a timely manner. A complete record, certified by the testing laboratory, of all air monitoring tests and results will be furnished to the Owner's Representative, the Owner and the Contractor.
16. Air samples may be analyzed on site by the Owner's Representative, if they are to be analyzed by the NIOSH 7400 Method.
17. Cellulose ester filters will be analyzed using the PCM NIOSH 7400 Method. Thus analysis will be carried out at a laboratory located off the job site.
18. At the completion of the work in occupied areas and prior to the dismantling of the isolation system, final air clearance will be conducted by the Owner's Representative.
19. Decontamination of the work area will be considered complete when all samples indicate fiber levels are less than 0.0l f/cc of air as analyzed by PCM NIOSH 7400 Method or an average of less than 70 structures per square millimeter of filter area as analyzed by TEM; Level II AHERA Method.
20. The Contractor may conduct its own air monitoring and laboratory testing. If it elects to do this the cost of such air monitoring and laboratory testing shall be included in the Contract Sum.

P. Equipment Removal Procedures
1. Clean all external surfaces of contaminated waste containers and equipment thoroughly by wet sponging or HEPA vacuuming before moving such items into the equipment decontamination enclosure system washroom for final cleaning and removal to uncontaminated areas. Ensure that personnel do not leave the work areas through the equipment decontamination enclosure system.

Q. Disposal Activities
1. It is the responsibility of the Contractor to comply with current federal, state and local regulations concerning the waste handling, transportation, and disposal of asbestos-containing material (ACM) and accompanying solvents or residues.
2. The Contractor will document actual disposal of the waste at the designated landfill by completing Disposal Certificate or submitting proof of landfill receipt.

1.2 PRODUCTS

A. Materials
1. All Contractor's equipment delivered to the site shall be free of asbestos contamination.
2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
3. Damaged or deteriorating materials shall not be used and shall be removed from the premises. Materials that become contaminated shall be disposed of in accordance with applicable regulations.

4. Polyethylene flame retardant sheet of 6-mil thickness shall be used unless otherwise specified. Polyethylene sheeting shall be sized to minimize the frequency of joints. Polyethylene sheeting must satisfy the National Fire Prevention Association Standard 701, "Small Scale Fire Test for Flame Resistant Textile and Film."
5. Adhesive tape shall be capable of sealing joints of adjacent sheets of polyethylene and for use in attachment of polyethylene sheet to finished or unfinished surfaces of similar materials and shall be capable of adhering under dry and wet conditions, including use of amended water. Contractor shall use adhesive tape compatible with finished surfaces.
6. Protective devices such as, but not limited to, disposable clothing, respirators, gloves, hard hats, etc. shall be used.
7. Wetting agent shall be a mixture of 50/50 polyoxyethylene ether and polyglycol ester or equivalent commercial product.
8. Encapsulant materials shall be the bridging and penetrating type and conform with the following characteristics:
    a. Encapsulants shall not be solvent-based or utilize a hydrocarbon in the liquid in which the solid parts of the encapsulant are suspended.
    b. Encapsulant shall not be flammable.
9. A non-hardening lagging sealer for enclosing and sealing raw exposed edges and surfaces of asbestos-containing materials.
10. Pre-mixed or job mixed insulating plaster manufactured for use on plumbing equipment shall be used when repairing damaged thermal insulation material.
11. Non-woven fibrous glass mat and open weave glass fiber mat cloth for repair of thermal systems insulation.
12. Fire retardant sealant shall prevent fire, smoke, water and toxic fumes from penetrating through sealants. Sealant shall have a flame spread, smoke and fuel contribution of zero, and shall be ASTM and Underwriter's Laboratory (UL) rated for three hours for standard method of fire test for fire stop systems.

B. Tools And Equipment
1. Provide suitable tools for repair and encapsulation of asbestos-containing materials and for removal of asbestos-containing materials that are beyond repair. Wire brushes shall not be used as a means of removing or cleaning asbestos-containing materials from surfaces, if they are used as the surface is being sprayed with water or amended water.
2. Provide sufficient number of HEPA-filtered vacuum cleaners equipped with pick-up adapters, steel floor wands, crevice tools, and carpet tools.
3. Airless sprayers capable of spraying amended water shall be provided in sufficient number to allow continuous uninterrupted work.
4. Asbestos filtration devices shall utilize high efficiency particulate air (HEPA) filtration systems.
5. Transportation equipment, as required, shall be suitable for loading, temporary storage, and unloading of contaminated waste without exposure to persons or property, and shall be quiet in motion if used within the building.

1.3 EXECUTION

A. Safety Procedures For Power And Lighting
1. The use of wet methods for removal, repair, encapsulation or cleaning procedures increases the potential for electrical shock when working around electrical panels, conduit, light fixtures, alarm systems, junction boxes, transformers, etc. In coordination with the Owner, de-energize as much electrical equipment as possible to prevent electrical shock to employees performing the work. The Contractor shall use the following precautions:
    a. Use non-conductive tools and vacuum attachments.
    b. Utilize "hot line" covers over energized cables and power lines when possible.

c. Ensure all electrical equipment in use is properly grounded before the job starts. Check outlets, wiring, extension cords and power pickups.
d. Avoid stringing wiring across floors. Elevate wiring if possible.
e. Ensure electrical outlets are tightly sealed and taped to avoid water spray.
f. Determine operating voltages of equipment and lines before working on or near energized parts.
g. Energized parts must be insulated or guarded from employee contact and other conductive objects. Extension cords must be three-wire type and connected to a Ground Fault Interrupter (GFI) circuit.
h. Lock or secure de-energized circuits at panel and post warning signs.
i. Seal heating vents with two layers of polyethylene sheeting prior to the start of work. The Contractor shall repair any damage caused by Contractor's operations to duct work, grilles, dampers, louvers or HVAC equipment at the completion of the work at Contractor's expense. Coordinate all lock out and or de-energizing with the Owner.

B. Temporary Facilities
1. Use qualified tradesmen for installation of temporary services and facilities. Locate temporary services and facilities where they will serve the entire project adequately and result in minimum interference with the performance of the work and operations of the building. Coordinate all installations and shut downs with building owner.
2. Relocate, modify and extend services and facilities as required during the course of work so as to accommodate the entire work of the project.
3. Provide new or used materials and equipment that are undamaged and in serviceable condition. Provide only materials and equipment that are recognized as being suitable for the intended use, by compliance with appropriate standards.
4. During the erection and/or moving of scaffolding, care must be exercised so that the polyethylene floor covering is not damaged.
5. Clean, as necessary, debris from non-slip surfaces.
6. At the completion of abatement work, clean all construction aids within the work area, wrap in one layer of 6-mil polyethylene sheet and seal before removal from the work area.
7. Temporary water service connections to the Owner's water system shall include back flow protection. Valves shall be temperature and pressure rated for operation of the temperatures and pressures encountered.
8. Employ heavy-duty abrasion-resistant hoses with a pressure rating 50 percent greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit. Provide fittings as required to allow for connection to existing wall hydrants or spouts, as well as temporary water heating equipment, branch piping, showers, shut-off nozzles and equipment.
9. Electrical Services shall comply with applicable NEMA, NECA and UL standards and governing regulations for materials and layout of temporary electric service.
10. Provide a weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity, and power characteristics to accommodate performance of work during the construction period. Install temporary lighting adequate to provide sufficient illumination for safe work and traffic conditions in every area of work.
11. Provide receptacle outlets equipped with ground fault circuit interrupters, reset button and pilot light, for plug-in connection of power tools and equipment.
12. Use only grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Use single lengths or use waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas of work. All cords shall be elevated off the floor inside the containment area.
13. Temporary wiring in the work area shall be type UL non-metallic sheathed cable located overhead and exposed for surveillance. Do not wire temporary lighting with plain, exposed (insulated) electrical conductors. Provide liquid tight enclosures or boxes for wiring devices.

14. Provide Type "A" fire extinguishers for temporary offices and similar spaces where there is minimal danger of electrical or grease-oil-flammable liquid fires. In other locations provide type "ABC" dry chemical extinguishers, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.
15. Use of the Owner's existing toilet facilities, as indicated, will be permitted, so long as these facilities are properly cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore these facilities to the condition prevalent at the time of initial use. All provisions of these specifications regarding leaving the work area must be met.
16. When mini-enclosures area being used all of the requirements above will be enforced by the Owner's Representative. The construction and set-up of the mini-enclosures may be done by the Abatement Contractor.

C. Pressure Differential System
1. Before start of work Contractor shall submit design of pressure differential system to the Owner's Representative for review. Do not begin work until system has been approved by the Owner's Representative. Include in the submittal the following:
   a. Number of pressure differential machines required and the calculations necessary to determine the number of machines.
   b. Description of projected air-flow within work area and methods required to provide adequate air flow in all portions of the work area.
2. If the enclosure is not a mini-enclosure, the Contractor must supply the required number of asbestos air filtration units to the site in accordance with these specifications. Each unit shall include the following:
   a. Cabinet constructed of steel or other durable materials able to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Cabinet shall be factory sealed to prevent asbestos-containing dust from being released during use, transport, or maintenance. Access to and replacement of all air filters shall be from intake end. Unit shall be mounted on casters or wheels.
   b. Rate capacity of fan according to useable air-moving capacity under actual operating conditions. Use centrifugal-type fan.
   c. The final filter shall be the HEPA type. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame.
   d. A continuous rubber gasket shall be located between the filter and the filter housing to form a tight seal.
   e. Provide HEPA Units that are individually tested and certified on site by an independent testing agency to have an efficiency of not less than 99.97 percent when challenged with 0.3 m dioctylphthlaate (DOP) particles when tested in accordance with Military Standard Number 2182 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions.
   f. Pre-filters, which protect the final filter by removing the larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. The first-stage pre-filter shall be a low-efficiency type (e.g., for particles 10 microns and larger). The second-stage (or intermediate) filter shall have a medium efficiency (e.g., effective for particles down to 5 microns). Pre-filters and intermediate filters shall be installed either on or in the intake grid of the unit and held in place with special housings or clamps.
   g. Each unit shall be equipped with a Magnahelic gauge or manometer to measure the pressure drop across filters and indicate when filters have become loaded and need to be changed. A table indicating the useable air-handling capacity for various static pressure readings on the Magnahelic gauge shall be affixed near the gauge for reference, or the Magnahelic reading indicating at what point the filters should be changed, noting Cubic Feet per Minute (CFM) air delivery at that point. Provide units equipped with an elapsed time meter to show the total accumulated hours of operation.

h. The unit shall have an electrical (or mechanical) lockout to prevent fan from operating without a HEPA filter. Units shall be equipped with automatic shutdown system to stop fan in the event of a major rupture in the HEPA filter or blocked air discharge. Warning lights are required to indicate normal operation, too high a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge).

i. Electrical components shall be approved by the National Electrical Manufacturers Association (NEMA) and Underwriters' Laboratories (UL). Each unit shall be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet shall be grounded.

j. If a mini-enclosure is used the air filtration unit may be a HEPA filtered vacuum with a flow rate of at least 100 cubic feet per minute (CFM).

3. Provide a fully operational pressure differential system within the work area maintaining continuously a pressure differential across work area enclosures of 0.02 inches of water for glove bag operations and mini-containments**.** Demonstrate to the Owner's Representative the pressure differential by use of pressure differential meter or a manometer, before disturbance of any asbestos-containing materials. In the case of a mini-enclosure visual evidence of pressure differential through the use of a smoke generation tube shall be sufficient as in paragraph C.13 of this section.
4. Continuously monitor and record the pressure differential between the work area and the building outside of the work area.
5. Provide fully operational negative pressure systems supplying a minimum of one air change every ten minutes (six changes per hour), less in the instance of a mini-enclosure. Determine the volume in cubic feet of the work area by multiplying floor area by ceiling height. Determine total ventilation requirement in cubic feet per minute (cfm) for the work area by dividing this volume by the air change rate.
6. Ventilation Required (CFM) = Volume of work area (cu. ft.)/10 min.
7. Determine number of units needed to achieve ten-minute change rate by dividing the ventilation requirement (CFM) above capacity of exhaust unit(s) used. Capacity of a unit for purposes of this section is the capacity in cubic feet per minute with fully loaded filters (pressure differential which causes loaded filter warning light to come on) in the machines labeled operating characteristics.
8. Add one additional unit as a backup in case of equipment failure or machine shutdown for filter changing.
9. Locate exhaust unit(s) so that makeup air enters work area primarily through decontamination facilities and traverses work area as much as possible. This may be accomplished by positioning the unit(s) at a maximum distance from the worker access opening or other makeup air sources.
10. Vent to outside of building, unless authorized in writing by the Owner's Representative.
11. Each unit shall be serviced by a dedicated minimum 115v-20A circuit with overload device tied into an existing building electrical panel which has sufficient spare capacity to accommodate the load of all pressure differential units connected. Dedication of an existing circuit may be accomplished by shutting down existing loads on the circuit.
12. Test pressure differential system before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, start the unit(s) (one at a time). Demonstrate operation and testing of pressure differential system to the Owner's Representative.
13. Demonstrate of operations of the pressure differential system to the Owner's Representative will include, but not be limited to, the following:
    a. Plastic barriers and sheeting move lightly in toward work area.
    b. Curtain of decontamination units move lightly in toward work area.
    c. There is a noticeable movement of air through the decontamination unit. Use stroke tube to demonstrate air movement from clean room, and from equipment room to work area.
    d. Use smoke tubes to demonstrate a positive motion of air across all area in which work is to be performed.

e. Use a differential pressure meter or manometer to demonstrate a pressure difference of at least 0.02 inches (as allowed) of water across every barrier separating the work area from the balance of the building or outside. This is not required in the case of a mini enclosure.

14. Start exhaust units before beginning work (before any asbestos-containing material is disturbed). After abatement work has begun, run units continuously to maintain a constant negative pressure until decontamination of the work area is complete. Do not turn off units at the end of the work shift or when abatement operations temporarily stop.
15. Do not shut down pressure differential system during encapsulating procedures, unless authorized by the Owner's Representative in writing. Start abatement work at a location farthest from the exhaust units and proceed toward them. If an electric power failure occurs, immediately stop all abatement work and do not resume until power is restored and exhaust units are operating again.
16. At completion of abatement work, allow exhaust units to run as specified to remove airborne fibers that may have been generated during abatement work and cleanup and to purge the work area with clean makeup air. The units may be required to run for a longer time after decontamination, if dry or only partially wetted asbestos material was encountered during any abatement work. In the case of a mini-enclosure the vacuum may be removed and the entrance sealed following encapsulation until the clearance sample is collected.
17. Prior to final air test, remove pre-filter and wipe out inside lip of negative air machine.
18. When a final inspection and the results of final air tests indicate that the area has been decontaminated, exhaust units may be removed from the work area. Before removal from the work area, remove and properly dispose of pre-filter, and seal Intake to the machine with 6-mil polyethylene to prevent environmental contamination from the filters.

D. Work Area Preparation

1. The work area is the location where asbestos-abatement work occurs. It is a variable of the extent of work of the contract. It may be a portion of a room, a single room, or a complex of rooms. A "work area" is considered contaminated during the work, and must be isolated from the balance of the building, and decontaminated at the completion of the asbestos-control work.
2. Pre-clean fixed objects, walls and floor surfaces within the proposed work areas using HEPA filtered vacuum equipment and wet cleaning methods as appropriate.
3. Seal all openings, supply and exhaust vents, and convectors within ten feet of the work area with 6-mil polyethylene sheeting secured and completely sealed with plastic adhesion tape.
4. Contact fire control agencies to review procedures prior to start of work.
5. Provide flame resistant polyethylene sheeting that conforms to requirements set forth by the National Fire Protection Association Standard 701, Small Scale Fire Test for Flame-resistant Textiles and Films. Provide largest size possible to minimize seams, four- or six- mils thick, frosted or black.
6. Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene and supporting surface.
7. Completely isolate the work area from other parts of the building so as to prevent asbestos-containing dust or debris from passing beyond the isolated area. Should the area beyond the work area(s) become contaminated with asbestos-containing dust or debris as a consequence of the work, clean those areas in accordance with the procedures indicated in Paragraph "Decontamination Procedures." All such required cleaning or decontamination shall be performed at no additional cost to the Owner.
8. Place all tools (i.e., scaffolding, staging) necessary for the work in the area to be isolated prior to erection of plastic sheeting temporary enclosure.
9. Disable ventilation systems or any other system bringing air into or out of the work area. Disable system by disconnecting wires, removing circuit breakers, by lockable switch or other positive means that will prevent accidental premature restarting of equipment.
10. Remove and dispose of all electrical and mechanical items, such as lighting fixtures, clocks, diffusers, registers, escutcheon plates, etc., which cover any part of the surface on which work is to be performed.

11. All general construction items such as cabinets, casework, doors and window trim, moldings, ceilings, trim, etc., which cover the surface of the work as required to prevent interference with the work. To be performed by the Owner: clean, decontaminate and reinstall all such materials, upon completion of all removal work with materials, finishes, and workmanship to match existing installations before start of work.
12. Permit Access to the work area only through the Decontamination Unit. All other means of access shall be closed off and sealed and warning signs displayed on the clean side of the sealed access.
13. Provide Warning Signs at each visual and physical barriers reading as follows in both English and Spanish:

Legend	Notation
KEEP OUT	3" Sans Serif Gothic or Block
BEYOND THIS POINT	1" Sans Serif Gothic or Block
ASBESTOS ABATEMENT WORK	1" Sans Serif Gothic or Block
IN PROGRESS	1" Sans Serif Gothic or Block
BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH	14 Point Gothic

14. Alternate methods of containing the work area may be submitted to the Owner's Representative for approval. Do not proceed with any such method(s) without prior written approval of the Owner's Representative.
15. Individually seal all ventilation openings (supply and exhaust), lighting fixtures, clocks, doorways, windows, convectors and speakers, and other openings into the work area with plastic adhesion tape alone or with polyethylene sheeting at least 4-mil in thickness, taped securely in place with plastic adhesion tape. Maintain seal until all work including Project Decontamination is completed. Take care in sealing off lighting fixtures to avoid melting or burning of sheeting.
16. Provide sheet plastic barriers at least 6-mil in thickness as required to completely seal openings from the work area into adjacent areas. Seal the perimeter of all sheet plastic barriers with plastic adhesion tape or spray cement.
17. Where applicable, construct framing of the containment out of fire treated wood or aluminum studs. Mini-enclosure frames may be constructed of Polyvinyl Chloride (PVC) tubing.
18. Cover all walls in work area extending to the underside of the ceiling grid system with one layer of polyethylene sheeting, at least 6-mil in thickness, mechanically supported and sealed with plastic adhesion tape or spray-glue in the same manner as "Critical Barrier" sheet plastic barriers. Tape all joints with plastic adhesion tape. Contractor shall be responsible for repair of damaged wall finishes.
19. Cover floor with two layers of 6-mil polyethylene sheeting (exclude for floor tile and adhesive).
20. Provide Pressure Differential System per Paragraph “Pressure Differential System.”
21. If the enclosure barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, then add the affected area to the work area, enclose it as required by this section of the specification and decontaminate it as described in Paragraph “Decontamination Procedures.”
22. Establishing a Mini-Containment area:
    a. Establish work area so that unauthorized entry is prevented; Construct a two-compartment fire treated wood frame around work area; install one layer 6-mil polyethylene sheeting to structural members and two layers 6 mil polyethylene sheeting to the floor. Exception: no floor required if mini-containment is being constructed to perform a floor tile activity. Seal all edges to wall, ceiling, and floor surfaces with duct tape. Install viewing inspection windows, where feasible.
    b. Seal all penetrations with duct tape such as pipes, electrical conduit, or ducts contained within the mini-containment.

c. Install triple 6-mil polyethylene flaps at both doorways. Place portable sprayer with clean water, disposable towels, and pre-labeled disposal bag in air lock.
d. Install appropriate signs on outside of mini-containment area.
e. Install HEPA vacuum; extend hose into mini-containment area for general vacuuming, negative air, and cleaning of disposal suit.
f. Accumulate all loose materials for disposal. Place in approved container. Apply appropriate labels. Adequately wet clean all wall, floor, tool and equipment surfaces.
g. Abatement worker must wear two disposable suits. Remove outer suit in work area and place in a plastic bag. Enter air lock.
h. In air lock, wet wipe respirator and wash hands with clean water. Remove respirator and place in a clean plastic bag. Proceed to remote shower unit where inner suit may be removed.

E. Worker Protection
1. This section describes the equipment and procedures required for protecting workers against asbestos contamination and other work place hazards except for respiratory protection.
2. Respiratory Protection is specified in Paragraph “Respiratory Protection.”
3. Train in accordance with EPA’s Model Accreditation Plan, 40 CFR 763 - Asbestos, all workers in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. Include but do not limit the topics covered in the course to the following:
   a. Methods of recognizing asbestos.
   b. Health effects associated with asbestos.
   c. Relationship between smoking and asbestos in producing lung cancer.
   d. Nature of operations that could result in exposure to asbestos.
4. Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

   Engineering controls
   Work practices
   Respirators
   Housekeeping procedures
   Hygiene facilities
   Protective clothing
   Decontamination procedures
   Emergency procedures
   Waste disposal procedures
   Appropriate work practices for the work
   Requirements of medical surveillance program
   Review of OSHA 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos
   Pressure differential systems
   Work practices including hands on or on job training
   Personal decontamination procedures
   Air monitoring, personal and area

5. Provide medical examinations for all workers who may encounter an airborne fiber level of 0.1 f/cc or greater for an 8 hour time weighted average. In the absence of specific airborne fiber data, provide medical examination for all workers who will enter the work area for any reason. Examination shall, at minimum, meet OSHA requirements as set forth in 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos. In addition, provide an evaluation of the individual’s ability to work in environments capable of producing heat stress in the worker.
6. Before start of work Contractor shall submit the following to the Owner's Representative for review. Do not start work until receipt of the Owner’s Representative.

a. An original signed copy of the Certificate of Worker's Acknowledgement found at the end of this specification, for each worker who is to be at the job site or enter the work area.
b. Courses outline or name of institution providing the worker training course.
c. Report from medical examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area.

7. Provide disposable full-body coveralls and disposable head covers, and require that they be worn by all workers in the work area. Provide a sufficient number for all required changes, for all workers in the work area.
8. Provide work boots with non-skid soles, and where required by OSHA, foot protectives, for all workers. Provide boots at no cost to workers. Paint uppers of all boots red with water proof enamel. Do not allow boots to be removed from the work area for any reason, after being contaminated with asbestos-containing material. Dispose of boots as asbestos contaminated waste at the end of the work.
9. Provide head protectives (hard hats) as required by OSHA for all workers, and provide four spares for use by the Owner's Representative, and the Owner. Label hats with same warning labels as used on disposal bags. Require hard hats to be worn at all times that work is in progress that may potentially cause head injury. Provide hard hats with plastic strap type suspension. Require hats to remain in the work area throughout the work. Thoroughly clean, decontaminate and bag hats before removing them from work area at the end of the work.
10. Provide eye protectives (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity which may potentially cause eye injury.
11. Provide work gloves to all workers and require that they be worn at all times in the work area. Do not remove gloves from work area. Dispose of gloves as asbestos contaminated waste at the end of the work.
12. Respirators, disposable coveralls, head covers, and footwear covers shall be provided by the contractor for the Owner, the Owner's Representative, and other authorized representatives who may inspect the job site.
13. Provide worker protection as required by the most stringent OSHA and/or EPA standards applicable to the work. The following procedures are minimums to be adhered to regardless of fiber count in the work area.
14. Each time work is entered, remove <u>all</u> street clothes in the changing room of the Personnel Decontamination Unit and put on new disposable coverall, new head cover, and a clean respirator. Proceed through shower room to equipment room and put on work boots.
15. In the event a mini-enclosure is used refer to Paragraph "Work Area Preparation" for personal decontamination procedures.

F. Respiratory Protection

1. Instruct and train each worker involved in asbestos abatement or maintenance and repair of friable asbestos-containing materials in proper respiratory use and require that each worker always wear a respirator, properly fitted on the face in the work area from the start of any operation which may cause airborne asbestos fibers until the work area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the work place or as required for other toxic or oxygen-deficient situations encountered.
2. Except to the extent that more stringent requirements are written directly into the Contract Documents, the following regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies were bound herewith. Where there is a conflict in requirements set forth in these regulations and standards meet the more stringent requirement.
   a. OSHA - U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Standards 29 CFR 1910, Section 1001 and Section 1910.134.29 CFR 1926.
   b. ANSI - American National Standard Practices for Respiratory Protection. ANSI Z88.2-1980.
   c. NIOSH - National Institute for Occupational Safety and Health.

d. MSHA - Mine Safety and Health Administration.

G. Type Of Respiratory Protection Required

1. Provide Respiratory Protection as indicated in paragraph below. Where paragraph below does not apply, determine the proper level of protection by dividing the expected or actual airborne fiber count in the work area by the "protection factors" given below. The level of respiratory protection which supplies an airborne fiber level inside the respirator, at the breathing zone of the wearer, at or below 0.01 fibers/cubic centimeter is the minimum level of protection allowed.
2. Eight-hour Time Weighted Average (TWA) of asbestos fibers to which any worker may be exposed shall not exceed 0.1 fibers/cubic centimeter.
3. For purposes of this section fibers are defined as all fibers regardless of composition as counted in the OSHA Reference Method (ORM), NIOSH P&CAM 239 or 7400 procedure, or asbestos fibers of any size as counted using either a scanning or transmission electron microscope.
4. Require that respiratory protection be used at all times that there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental.
5. Require that a respirator be worn by anyone in a work area at all tunes, regardless of activity, during a period that starts with any operation which could cause airborne fibers until the area has been cleared for re-occupancy.

H. Respiratory Protection Factor

Respirator Type	Protection Factor
Air purifying: Negative pressure respirator High efficiency filter Half facepiece	10
Air purifying: Negative pressure respirator High efficiency filter Full facepiece	50
Powered-air purifying (PAPR): Positive pressure respirator High efficiency filter Half or Full facepiece	100
Type C supplied air: Positive pressure respirator continuous-flow Half or full facepiece	100
Type C supplied air: Positive pressure respirator pressure demand Full facepiece	1000
Type C supplied air: Positive pressure respirator pressure demand Full facepiece Equipped with an auxiliary positive pressure Self-contained breathing apparatus (SCBA)	over 1000
Self-contained breathing apparatus (SCBA): Positive Pressure respirator	over 1000

Pressure demand
Full facepiece

I. Air Purifying Respirator
   1. Provide half face or full face type respirators. Equip full-face respirators with a nose cup or other anti-fogging device as would be appropriate for use in air temperatures less than 32 degrees Fahrenheit.
   2. Provide, at a minimum, HEPA type filters labeled with NIOSH and MSHA certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-Containing Dusts and Mists" and color coded in accordance with ANSI Z228.2 (1980). In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH/MSHA Certification.
   3. Supply with a sufficient quantity of respirator filters approved for asbestos, so that workers can change filters during the work day. Require that respirators be wet-rinsed, and filters discarded, each time a worker leaves the work area. Require that new filters be installed each time a worker re-enters the work area. Store respirators and filters at the job site in the changing room and protect totally from exposure to asbestos prior to their use. Do not use single use, disposable or quarterface respirators.

J. Powered Air Purifying Respirator (PAPR)
   1. Provide full-facepiece type respirators. Provide nose-cups for full-facepiece respirators. Provide, at a minimum, HEPA type cartridges approved by NIOSH/MSHA and certified for use in atmospheres containing asbestos dusts.
   2. Provide, at a minimum, one extra battery pack for each respirator so that one can be charging while one is in use.
   3. Provide non-cloth belts capable of being decontaminated in shower.
   4. Supply with a sufficient quantity of high efficiency respirator filters approved for asbestos so that workers can change filters at any time that flow through the face piece decreases to the level at which the manufacturer recommends filter replacement. Require that regardless of flow, filter cartridges be replaced after 40 hours of use. Require that HEPA elements in filter cartridges be protected from wetting during showering. Require entire exterior housing of respirator including blower unit, filter cartridges, hoses, battery pack, face mask, belt, and cords to be washed each time a worker leaves the work area. Caution should be used to avoid shorting battery pack during washing.

K. Required Respiratory Protection
   1. Regardless of airborne fiber levels, require the following minimum level of respiratory protection:
      a. Half-face air purifying respirators may be used during set-up of the containment and removal of the material so long as fiber counts inside the respirator do not exceed .01 f/cc fibers per cubic centimeter.

L. Decontamination Units -Three-Stage
   1. Provide a Personnel Decontamination Unit consisting of a serial arrangement of rooms or spaces, Changing Room, Shower Room, Equipment Room adjacent to each full containment area.
   2. Require all persons without exception to pass through this decontamination unit for entry into and exiting from the work area for any purpose. Do not remove equipment or materials through Personnel Decontamination Unit.
   3. Changing (Clean) Room:
      a. Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing.
      b. Locate so that access to work area from changing room is through shower room.

c. Separate changing room from the building by a double-sheeted polyethylene flapped doorway.
d. Provide sub-panel at changing room to accommodate all removal equipment. Power sub-panel directly from a building electrical panel. Connect all electrical branch circuits in decontamination unit and particularly any pumps in shower room to a ground-fault circuit protection device.

4. Shower Room:
   a. Provide a completely water tight operational shower to be used for transit by cleanly dressed workers heading for the work area from the changing room, or for showering by workers headed out of the work area after undressing in the equipment room.
   b. Construct room by providing a shower pan and two shower walls in a configuration that will cause water running down walls to drip into pan. Install a freely draining wood floor in shower pan at elevation of top of pan.
   c. Separate this room from rest of building, drying room and airlock with airtight walls fabricated of 6-mil polyethylene.
   d. Provide splash proof entrances to Drying Room and Airlock.
5. Equipment Room (contaminated area):
   a. Require work equipment, footwear and additional contaminated work clothing to be left here. This is a change and transit area for workers. Separate this room from the work area by a 6-mil polyethylene flap doorway.
   b. Separate this room from the rest of the building, the shower room and work area with air tight walls fabricated of 6-mil polyethylene.
6. Clean Room: Provide Clean Room to isolate the holding room from the building exterior.
7. Load-out Area:
   a. The load-out area is the transfer area from the building to a truck or dumpster.
   b. Wet wipe bags before they are passed through the equipment decon-chamber.
   c. When cleaning is complete pass items into holding room. Close all doorways except the doorway between the holding room and the Clean Room.
   d. Workers from the area outside the containment area enter holding area and remove decontaminated equipment and/or containers for disposal.
   e. Require these workers to wear full protective clothing and appropriate respiratory protection.
   f. At no time is a worker from an uncontaminated area to enter the enclosure when a removal worker is inside.
   g. Post an approximately 20 inch x 14 inch manufactured caution sign at each entrance to the work area displaying the following legend with letter sizes and styles of a visibility required by OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos.

LEGEND
DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED
IN THIS AREA

   h. Provide spacing between respective lines at least equal to the height of the respective upper line.
   i. Additional Signage: Shall also be posted in accordance with OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA
DANGER
ASBESTOS
CANCER AND LUNG HAZARD
KEEP OUT

j. Post an approximately 10 inch by 14 inch manufactured sign at each entrance to each work area displaying the following legend with letter sizes and styles of a visibility at least equal to the following:

LEGEND	NOTATION
No Food, Beverages or Tobacco Permitted	3/4 inch Block
All Persons Shall Don Protective Clothing (Coverings) Before Entering the Work Area	3/4 inch Block
All Persons Shall Shower Immediately After Leaving Work Area and Before Entering the Changing Area	3/4 inch Block

M. Decontamination Procedures

1. Contractor shall require all workers and visitors to adhere to the following personal decontamination procedures whenever they leave the work area:

a. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area.
b. When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the Equipment Room.
c. Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
   1) Thoroughly wet body including hair and face. If using a PAPR, hold blower unit above head to keep canisters dry.
   2) With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.
   3) Take a deep breath, hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breathe.
   4) Carefully wash face-piece of respirator inside and out.
d. If using PAPR, shut down in the following sequence, first cap inlets to filter cartridges, then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack as this will short out and destroy battery.
   1) Shower completely with soap and water.
   2) Rinse thoroughly.
   3) Rinse shower room walls and floor prior to exit.
   4) Proceed from shower to changing room and change into street clothes or into new disposable work items.

e. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area with a half or full face cartridge type respirator:
   1) When exiting area, remove disposable coveralls, disposable headcovers, and disposable footwear covers or boots in the equipment room.
   2) Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator and filters to avoid asbestos fibers while showering. The following procedure is required as a minimum:
   3) Thoroughly wet body from neck down.
   4) Wet hair as thoroughly as possible without wetting the respirator filter if using an air purifying type respirator.
   5) Take a deep breath, hold it and/or exhale slowly, complete wetting of hair, thoroughly wetting face, respirator and filter (air purifying respirator). While still holding breath, remove respirator and hold it away from face before starting to breath.
   6) Dispose of wet filters from air purifying respirator.
   7) Carefully wash facepiece of respirator inside and out.
   8) Shower completely with soap and water.
   9) Rinse thoroughly.
   10) Rinse shower room walls and floor prior to exit.
   11) Proceed from shower to changing room and change into street clothes or into new disposable work items.

N. Project Decontamination
1. If the asbestos abatement work is on damaged or friable materials, then the building space is deemed contaminated before start of the work and in need of decontamination. In this case, the procedure includes two cleanings of the primary barrier plastic prior to its removal and two cleanings of the room surfaces to remove any new or existing contamination.
2. Work of this section includes the decontamination of air in the work area which has been, or may have been contaminated by the elevated airborne asbestos fiber levels generated during abatement activities, or which may previously have had elevated fiber levels due to friable materials in the space.
3. Work of this section also includes the cleaning, decontamination, and removal of temporary facilities installed prior to abatement work and decontamination of all surfaces (ceiling, walls, floor) of the work area, and all furniture or equipment in the work area.
4. First Cleaning
   a. Carry out a first cleaning of all surfaces of the work area including items of remaining sheeting, tools, scaffolding and/or staging by use of damp-cleaning and mopping, and/or a HEPA filtered vacuum. (Note: A HEPA vacuum will fail if used with wet material). Do not perform dry dusting or dry sweeping. Use each surface of a cleaning cloth one time only and then dispose as contaminated waste. Continue this cleaning until there is no visible debris from removed materials on plastic sheeting or other surfaces. Upon authorization of the Owner's Representative proceed with encapsulation of substrate.
   b. Perform encapsulation of substrate where required at this time. Maintain pressure differential system in operation during encapsulation work. Allow encapsulant to dry before proceeding with removal of Secondary layer of plastic.
5. Second Cleaning
   a. Upon authorization of the Owner's Representative, remove all Primary Barrier sheeting and Material Decontamination Unit, if there is one, leaving only the following:
      1) Critical Barrier which forms the sole barrier between the work area and other portions of the building or outside.
      2) Critical Barrier Sheeting over lighting fixtures and clocks, ventilation openings, doorways, convectors, speakers and other openings.

3) Personnel Decontamination Unit.
4) Pressure Differential System in continuous operation.

b. Remove all filters in Air Handling System(s) and dispose of as asbestos-containing waste.

6. Final Cleaning: Carry out a final cleaning of all surfaces in the work in the same manner as the first cleaning immediately after removal of primary plastic. This cleaning is now being applied to existing room surfaces. Take care to avoid water marks or other damage to surfaces.
7. Visual Inspection: Perform a complete visual inspection with the Owner's Representative of the entire work area including decontamination unit, all plastic sheeting, seals over ventilation openings, doorways, windows, and other openings; look for debris from any sources, residue on surfaces, dust or other matter. If any such debris, residue, dust or other matter is found repeat cleaning and continue decontamination procedure from that point. When the area is visually clean, complete the certification at the end of this section.
8. Final Air Sampling
   a. After the work area is found to be visually clean, air samples will be taken and analyzed in accordance with the procedures set forth in Paragraph “Powered Air Purifying Respirator (PAPR).
   b. If Release Criteria are not met, repeat cleaning and continue decontamination procedure from that point.
   c. If Release Criteria is met, remove the interior of the decontamination unit leaving in place only the Critical Barriers separating the work area from the rest of the building and the operating negative pressure system.
   d. Any small quantities of residual material found upon removal of the plastic sheeting shall be removed with a HEPA filtered vacuum cleaner and local area protection. If significant quantities, as determined by the Owner's Representative, are found then the entire area affected shall be decontaminated as specified herein for the cleaning.

O. Work Area Clearance
1. Air Monitoring
   a. Visual Inspection is required as a prerequisite of air testing.
   b. To determine if the elevated airborne asbestos structure concentration during abatement operations have been reduced to the specified level, the Owner's Representative will secure samples and analyze them according to the following procedures.
2. Aggressive Sampling
   a. All air samples will be taken using aggressive sampling techniques as follows. (There are no standards available for flow rate of leaf blowers or large fans. However, this information is not critical to the success of the procedure).
   b. Before sampling pumps are started, the exhaust from forced-air equipment (leaf blower with at least 1 horsepower electric motor) will be swept against all walls, ceilings, floors, ledges and other surfaces in the room. This procedure will be continued for five minutes per 10,000 cubic feet of room volume.
   c. Air samples will be collected in areas subject to normal air circulation away from room corners, obstructed locations, and sites near windows, doors or vents.
3. Schedule of Air Samples
   a. General: The number and volume of air samples taken and analytical methods used by the Owner's Representative will be in accordance with the following schedule. Sample volumes given may vary depending upon the analytical instruments used. In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM of TEM analysis.
   b. Transmission Electron Microscopy (TEM) Samples:
      1) In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM or TEM analysis as follows:
      2) Samples will be collected on 25 mm cassettes with filter media: TEM - 0.45 micrometer mixed cellulose ester or 0.40 micrometer polycarbonate, with 5.0 micron mixed cellulose ester backing filter.

Location **Sampled**	Number of **Samples**	Detection **Limit** (f/cc)	**Minimum** Volume (Liters)	**Rate** LPM
Each Work Area	5	0.005	1,300	2-10

3) TEM Analysis will be performed using the analysis method set forth in the AHERA Regulation 40 CFR Part 763 Appendix A.
4) Asbestos Structures referred to in this Section include asbestos fibers, bundles, clusters, or matrices, as defined by method of analysis.
5) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

c. Phase Contrast Microscopy (PCM) Samples:
1) In each homogeneous work area after completion of all cleaning work, samples may be taken and analyzed as follows:
2) Samples will be analyzed by PCM for clearance in areas where ceiling tile and/or pipe insulation are removed
3) Samples will be collected on 25 mm cassettes with filter media: PCM - 0.8 micrometer mixed cellulose ester.

Location Sampled	**Number of Samples**	**Detection Limit** (s/cc)	**Minimum Volume** (Liters)	**Rate** LPM
Each Work Area	1-5	0.01	2,400	2-10

4) PCM Analysis: Fibers on each filter will be measured using the NIOSH 7400 Method entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987.
5) Fibers: Referred to in this section include fibers regardless of composition as counted by the phase contrast microscopy method used
6) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

4. Failure of Clearance Sampling: Should results from analysis of final clearance air samples not meet the specified criteria, Contractor will be responsible for the payment of all costs, including Consultant's time for subsequent clearance air sampling. The costs associated with subsequent re-sampling for final clearance shall be deducted from the Contractor's final payment of the contract amount.

P. Removal Of Pipe Insulation
1. The work of this section applied to the removal of asbestos-containing Pipe Insulation.
a. Place one layer of 6-mil fire retardant polyethylene sheeting directly below the work. The sheet shall be of sufficient size to completely wrap the pipe once it has been removed.
b. Thoroughly wet the ends of the pipe with amended water and scrape off a minimum of 6 inches of asbestos wrap from both ends of the pipe. Immediately place the wetted material into pre-labeled asbestos disposal bag(s).
c. Detach the pipe at each scraped end and place the pipe onto one sheet of 6-mil fire retardant polyethylene sheeting. Wrap the pipe with the 6-mil fire retardant polyethylene sheeting. Contractor shall wrap the pipe with a second sheet of 6-mil, fire retardant polyethylene sheeting and label as asbestos-containing material. Dispose of the bag(s) and duct in accordance with the Paragraph "Handling and Disposal of Asbestos Contaminated Waste" of this specification.
d. Upon clearance from the Owner's Representative, Contractor shall remove the 6-trail, fire retardant polyethylene sheeting from the openings.

Q. Glove Bag Removal

1. The work of this section applies to full containment or glovebag removal.
2. Isolate the area in accordance with Paragraph "Temporary Facilities."
3. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area.
4. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Pressure Differential System."
    a. Upon approval of the enclosure by the Owner's Representative, Contractor may proceed to remove the material using the following method.
    b. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing insulation to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions. If insulation is covered with canvas, Contractor will wet the exterior covering and slice it with utility knife while saturating the material.
    c. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
    d. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
    e. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
    f. Contractor must always clean area of visible asbestos debris prior to end of shift.
5. These procedures shall be followed to remove pipe insulation elbows:
    a. Install critical barriers to isolate the work site. Install 2 or 3 Stage Decontamination Units.
    b. HEPA vacuum the work site.
    c. Provide negative air machine in addition to those required, in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 2-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
    d. Locate intake of duct so that airflow is horizontally and slightly downward into intake. Replace primary filter on negative air machine at an interval of no greater than 30 minutes. Allow no more than one scraping or brushing activity per negative air machine.
    e. Check pipe where the work will be performed. Wrap damaged (broken lagging, hanging, etc.), pipe in 6 mil plastic and "candy-stripe" with duct tape. Place one layer of duct tape around undamaged pipe at each end where the glovebag will be attached.
    f. Place necessary tools into pouch located inside glovebag. This will usually include: bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and pre-wetted cloth.
    g. Place one strip of plastic adhesion tape along the edge of the open top slit of glove bag for reinforcement.
    h. Place the glove bag around section of pipe to be worked on and staple top together through reinforcing tape. Next, tape the ends of glovebag to pipe itself, where previously covered with plastic or tape.
    i. Use smoke tube and aspirator bulb to test seal. Place tube into water sleeve (two-inch opening to glovebag) squeezing bulb and filling bag with visible smoke. Remove smoke tube and twist water sleeve closed. While holding the water sleeve tightly, gently squeeze glovebag and by using a flashlight, look for smoke leaking out, (especially at the top and ends of the glovebag). If leaks are found, tape closed using plastic adhesion tape and re-test.
    j. Insert wand from garden sprayer through water sleeve. Plastic adhesion tape water sleeve tightly around the wand to prevent leakage.

k. One person places its hands into the long-sleeved gloves while the second person directs garden sprayer at the work.
l. Use bone saw, if required, to cut insulation at each end of the section to be removed. A bone saw is a serrated heavy gauge wire with ring-type handles at each end. Throughout this process, spray amended water or removal encapsulant on the cutting area to keep dust to a minimum.
m. Remove insulation using putty knives or other tools. Place pieces in bottom of bag without dropping.
n. Rinse all tools with water inside the bag and place back into pouch.
o. Using scrub brush, rags and water, scrub and wipe down the exposed pipe. (Inexpensive horse rub-down mittens work well for this).
p. Remove water wand from water sleeve and attach the small nozzle from HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag.
q. Remove the vacuum nozzle, twist water sleeve closed and seal with plastic adhesion tape.

R. Handling And Disposal Of Asbestos-Containing Waste
1. All waste and asbestos contaminated waste shall be double bagged in pre-labeled 6-mil airtight puncture resistant bags. Labeling shall be in accordance with OSHA and EPA requirements.
a. Bags of asbestos-containing waste shall be sealed with tape in the work area. Asbestos waste shall not be allowed to dry out prior to sealing bags. While in the work area, bags shall be decontaminated of any bulk debris by wet wiping. Bags shall be pre-labeled in accordance with OSHA and EPA.
b. The Contractor shall ensure that the sealed bags are transported to the waste disposal site.
2. The Contractor shall establish a manifest system to enable the Owner to report the quantity of asbestos waste being deposited at the landfill. Contractor shall report the quantity of waste in pounds or tons as appropriate. The Contractor must be able to demonstrate custody over all asbestos waste from the time it is removed from the work area until it is deposited at the land fill.
a. Copies of the manifest and any receipts generated during the handling and disposal process shall be provided to the Owner's Representative and the Owner.
b. Final manifest and documents must be provided to the Owner's Representative and the Owner within two weeks of the removal of the asbestos materials from the site by the waste hauler.

S. Encapsulation Of Asbestos-Containing Materials
1. General provisions of Contract, including General and Supplementary Conditions and Division 1, apply to work of this section.
a. The work includes the sealing of all piping or vessels from which asbestos-containing insulation has been removed with one coat of a lock down encapsulant.
b. Where repair work is being performed, the end will be sealed with a minimum of one coat of bridging encapsulant.
2. Submittals
a. Product Data: Submit manufacturer's technical information including label analysis and application instructions for each material proposed for use.
b. Installation Instructions: Submit manufacturer's installation instructions with specific project requirements noted.
c. Performance Warrantee: Submit manufacturer's performance guarantee.
d. Certification: Submit written approval of entity installing the encapsulant from encapsulant manufacturer.
e. Safety Data Sheet: Submit the Safety Data Sheet, or equivalent, in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

3. Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
   a. Name or title of material
   b. Manufacturer's stock number and date of manufacture
   c. Manufacturer's name
   d. Thinning Instructions
   e. Application Instructions
4. Deliver materials together with a copy of the OSHA Safety Data Sheet for the material.
5. Job Conditions
   a. Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.
6. Quality Assurance
   a. Installation of Spray-on Encapsulation Materials: Install spray-on materials by a firm and personnel approved by the manufacturer of the primary materials.
   b. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Performance Warranty: Submit written Performance Warranty, executed by the manufacturer and co-signed by the Contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, non-foreseeable ambient exposures or other causes beyond anticipated conditions and manufacturer's/contractor's control.
   d. Compatibility: Selection and use of encapsulant shall be compatible with replacement materials. Submit manufacturer's data indicating compatibility with replacement materials.
7. Product Selection
   a. Encapsulants: Provide penetrating or bridging type encapsulants specifically designed for application to asbestos-containing material.
   b. Standards: Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
   c. Fire Safety: Use only materials that have a flame spread index of less than 25, when dry, when tested in accordance with ASTM E84.
8. Manufacturers
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the work, include, but are not limited to the following:
      1) Penetrating Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
      2) Bridging Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
9. General
   a. Prior to applying any encapsulating material, ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
   b. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.
10. Worker Protection
    a. Before beginning work with any material for which a Safety Data Sheet has been submitted, provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

b. In addition to protective breathing equipment required by OSHA requirements or by this specification, use painting pre-filters on respirators to protect the dust filters when organic solvent based encapsulants are used.

11. Substrate
    a. Apply lock down encapsulant to all substrate after all asbestos-containing materials have been removed. Apply in strict accordance with the manufacturer's printed instructions for use of the encapsulation as an asbestos coating. Any deviations from such printed instructions shall be approved by the Owner's Representative in writing prior to commencing work.
    b. Apply encapsulant with an airless spray gun with air pressure and nozzle orifice as recommended by the encapsulant manufacturer.

T. Removal Of Floor Tile
1. This section applies to the removal of floor tile.
    a. Prior to start of work, wet wipe all surfaces including floor tile to remove any visible dust.
    b. Isolate the room by sealing hallway or doors and installing critical barriers on all ducting, windows and other penetrations of the room, in the specified area. Install a splash guard a minimum of 4 feet high on the walls of the room with one layer of 6-mil fire retardant poly.
    c. Install a two-stage decontamination configuration contiguous (under certain conditions may be remote) with the work in accordance with Paragraph “Decontamination Units.”
    d. Using water or amended water in a Hudson-type sprayer or garden sprayer, lightly mist the area where the material is to be removed. This may take several passes with the hose of the sprayer. Allow time for the water to soak into the material.
    e. Immediately place individual tiles in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place the bag into a second prelabeled disposal bag. Tape shut the second bag.

U. Removal Of Fireproofing
1. The work of this section applies to the removal of all asbestos containing fireproofing including all over-spray that may be located on concrete block, columns, metal deck, beams, fixtures conduit and ducting.
    a. Isolate the floor per Paragraph “Temporary Enclosure.”
    b. Construct a decontamination unit as described in Paragraph “Decontamination Units” and attach to the work area.
    c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph “Temporary Pressure Differential and Air Circulation System.”
    d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method.
    e. Pre-clean columns, beams, electrical, mechanical and plumbing systems in the work area using wet wipe and HEPA vacuuming methods. Mask off with flame retardant polyethylene sheeting to protect from contamination during bulk abatement.
    f. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing fireproofing to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions.
    g. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
    h. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into

disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.

i. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.

j. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 12" diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.

k. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on pressure differential machine at an interval of no greater that 30 minutes. Allow no more than one scraping or brushing activity per pressure differential machine.

V. Removal Of Wall Plaster: HEPA vacuum work site.

1. Place two layers of 6-mil flame retardant polyethylene sheeting on the floor adjacent to the wall to be demolished. Pull the wall down in manageable sections onto the polyethylene sheeting. Control dust and fiber release by misting the air and lightly wetting the material with amended water from a Hudson-type sprayer or garden sprayer as it is demolished.
2. Wrap the first layer of polyethylene sheeting around the material and seal with duct tape. Wrap the second layer of polyethylene sheeting around the bundle and seal with duct tape.
3. Label and dispose of the entire bundle.
4. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is unto the work area, oriented in a direction away from the work. Extend a 12-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
5. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on negative air machine at an interval of no greater that 30 minutes.

W. Clean-Up Of Asbestos-Containing Debris On Ceiling Tile Or Solid Ceiling

1. This section applies to the decontamination of the entire plaster ceiling, removal of existing fiberglass on duct work and removal of all batt insulation covering the existing plaster ceiling.
   a. Isolate the floor per Paragraph "Temporary Facilities."
   b. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area. General Contractor will give direction regarding exact location of decontamination unit(s).
   c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Temporary Pressure Differential and Air Circulation System."
   d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method:
2. These procedures shall be followed to for clean up of asbestos-containing debris on existing plaster ceiling:
   a. This work will be performed prior to the removal of fireproofing. The isolation of the work area is considered essential to the pre-cleaning activities for the total area. Isolate the area in accordance with Paragraph “Temporary Facilities.”
   b. Remove asbestos-containing debris and fiberglass batt and duct insulation and decontaminate the area using the following procedures:
      1) Remove all small debris with the HEPA vacuum.
      2) Gently mist all fiberglass insulation, remove from ducts and ceiling and place into pre-labeled hazardous disposal bags and dispose of in accordance with Paragraph “Disposal of Asbestos Containing Waste Material.”
      3) Exposure of ducting will expose all fireproofing overspray, this material may be removed during the removal of fireproofing from decks and beams.

4) Pick up all large visible debris on the ceiling or any horizontal surfaces and place in the bottom of a 6-mil polyethylene disposal bag conforming to the requirements of Paragraph “Disposal of Asbestos-Containing Waste.” Place pieces in the bag without dropping and avoiding unnecessary disturbance and release of material.
5) HEPA vacuum the entire plaster ceiling surface.

c. Upon completion of the decontamination of the area request a visual inspection of the ceiling and other horizontal surfaces. This area will be considered a portion of work area for the duration of the work and will be included in the final encapsulation of the area.

X. Removal Of Adhesive: This section applies to the removal of all asbestos-containing floor tile and adhesive, sheet vinyl flooring, vinyl floor tile, and baseboard adhesive, etc.

1. Ensure that workers are equipped with proper respiratory protection. In addition to the HEPA cartridges, respirators must also be equipped with organic solvent cartridges.
2. Provide HEPA filtered fan units in the vicinity of the work. Arrange so that units exhaust outside the building. Replace primary filters on HEPA filtered fan units at an interval of no greater than 30 minutes.
3. Apply adhesive removal solvent as recommended by manufacturer after removal of floor tile has been completed.
4. Provide tile adhesive (mastic) remover that meets the following criteria:
   a. Flash Point: 122E or greater.
   b. Special Precautions: No heavy smoke generated if ignited.
   c. Health Effects: Limited to mild skin rash or eye irritation.
   d. Respiratory Protection: MSHA - NIOSH approved Organic vapor cartridges in conjunction with standard HEPA filters.
   e. Petroleum Distillates: None.
   f. Odor: Pine, Citrus or none.

Use of diesel fuel in the removal of tile and baseboard adhesive is strictly prohibited.

5. Remove adhesive in small sections from all areas. Do not allow material to dry out. As adhesive is removed, simultaneously pack rags contaminated with adhesive material into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside of bag and move to material decontamination unit.
6. Upon completion of adhesive removal, thoroughly clean bare substrate of all solvent residue.
7. Place adhesive residue in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place bag into second prelabeled disposal bag. Tape shut the second bag.

CERTIFICATE OF WORKER'S ACKNOWLEDGEMENT

PROJECT NAME: _____

PROJECT ADDRESS: _____

CONTRACTOR: _____

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCER IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with the Owner for the above project requires that: You be supplied with the proper respirator and be trained in its use. You be trained in safe work practices and in the use of the equipment found on the job. You receive a medical examination. These things are to have been done at no cost to you. By signing this certification you are assuring the Owner that your employer has met these obligations to you.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators, and informed ofthe type respirator to be used on the above referenced project. I have a copy of the written respiratory protection manual issued by my employers. I have been equipped at no cost with the respirator to be used on the above project.

TRAINING COURSE: I have been trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. The topics covered in the course included the following:

- Physical characteristics of asbestos
- Health hazards associated with asbestos
- Respiratory protection
- Use of protective equipment
- Pressure differential systems
- Work practices including hands-on or on-the-job training
- Personal decontamination procedures
- Air monitoring, personal and area

MEDICAL EXAMINATION: I have had a medical examination within the last 12 months which was paid for by my employer. This examination included: health history, pulmonary function tests and may have included an evaluation of a chest x-ray.

Signature _____ Witness _____

Printed Name _____ Social Security Number _____

CERTIFICATION OF VISUAL INSPECTION

AREA _____

In accordance with Paragraph "Project Decontamination" the Contractor hereby certifies that it has visually inspected the work area (all surfaces including pipes, beams, ledges, walls, ceiling and floor, Decontamination Unit, sheet plastic, etc.) and has found no dust, debris or residue.

By: _____

Signature _____ Date _____

Print Name _____

Print Title _____

OWNER'S REPRESENTATIVE CERTIFICATION

the Owner's Representative hereby certifies that it has accompanied the Contractor on its visual inspection and verifies that this inspection has been thorough and to the best of its knowledge and belief, the Contractor's certification above is a true and honest one.

Signature _____ Date _____

Print Name _____

Print Title _____

RESPIRATORY PROTECTION PROGRAM

Project Name _____

Location _____

Date _____

Based upon airborne asbestos-fiber counts encountered on previous projects of similar type working on materials similar to those found on the above referenced project. The following level of respiratory protection is proposed for the indicated operations to maintain an Airborne Fiber Count (as measured by the NIOSH 7400 Method) below the specified Permissible Exposure Limit (PEL) inside the respirator face piece.

Operation	Anticipated f/cc	Respiratory Protection	Protection Factor	f/cc in Mask
Installing sheet plastic				
Removing trim in contact with asbestos-containing material				
Removal of architectural finish or fireproofing				
Removal of pipe insulation				
Removal of fitting insulation				
Encapsulation of pipe and boiler insulation				
Gross debris removal				
Cleaning "primary" sheet plastic				
Cleaning "critical" barrier				
Removing Decontamination Unit				
Other				

The Contractor certifies that to the best of its knowledge and belief the above represent a true and accurate representation of Airborne Fiber Counts to be expected for the operations indicated, and are based upon airborne fiber data from past projects with similar materials and operations.

Contractor _____

Signature _____ Date _____

Print Name _____ Title _____

END OF SECTION 02 82 33 00

SECTION 02 82 33 00a - REMOVAL OF NONFRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for removal of nonfriable asbestos-containing materials. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions

1. ACM: Asbestos Containing material which is any material containing more than one percent asbestos.
2. Amended Water: Water containing a wetting agent or surfactant with a maximum surface tension of 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.
3. Area Sampling: Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.
4. Asbestos: The term asbestos collectively refers to a naturally occurring mineral known by the following specific names: chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
5. Asbestos control Area: That area where asbestos removal operations are performed. The area shall be isolated by physical boundaries to assist in the prevention of the uncontrolled access by non-qualified persons.
6. Asbestos Fibers: Those fibers having an aspect ratio of at least 3:1 and longer than-5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.
7. Asbestos Permissible Exposure Limit: 0.1 fibers per cubic centimeter of air as an e-hour time weighted average measured in the breathing zone as by defined 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.
8. Background: The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for contaminated areas are measured in similar but asbestos free locations.
9. Contractor: The Contractor is that individual, or entity under contract to the Owner to perform the herein listed work.
10. Contractor/Supervisor (Asbestos abatement): A person who has successfully completed training and is therefore accredited as a Contractor/Supervisor under a State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763.
11. Critical Barrier: The layer of polyethylene sheeting that covers an opening or penetration in a room or area that is to become a negative pressure enclosure.
12. Encapsulation: The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.
13. Encapsulants: Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.
    a. Removal Encapsulant (can be used as a wetting agent)
    b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)
    c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
    d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).

14. Friable Asbestos Material: Any material containing more than one percent asbestos that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.
15. Glovebag Technique: Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.
16. HEPA Filter Equipment: High efficiency particulate air (HEPA) filtered vacuum and/or exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.
17. the Owner: That qualified person employed directly by the Owner to monitor, sample, inspect the work, and advise the Owner.
18. Negative Pressure Enclosure (NPE): That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.
19. Non-friable Asbestos Material: Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, renovation, removal, or mishap.
20. Personal Sampling: Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.
21. Competent Person (CP): A person who has successfully completed training and is therefore accredited under a legitimate State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763 as a Contractor/Supervisor and shall be appropriately licensed according to the Statutes of the State in which the work is to be performed.
22. TEM: Refers to Transmission Electron Microscopy.
23. Time Weighted Average (TWA): The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.
24. Wetting Agent: A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.

C. Requirements
1. Description of Work: The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures shall be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the use of non-friable removal technique(s) which is governed by 40 CFR 763 as indicated. Provide non-friable removal technique(s) as outlined in this specification for the locations indicated.
2. Medical Requirements: Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.
    a. Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."
    b. Medical Records: Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 30 years after termination of employment and make records of the required medical examinations and

exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

c. Medical Certification: Submit written certification for each worker and contractor/supervisor, signed by a licensed physician indicating that the worker and contractor/supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1910.134 as prescribed by law.

3. Training: Train all personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. The Contractor shall document the training by providing a copy of a current training certification to the the Owner for each person assigned to work on this project. Furnish each employee with respirator training and fit testing documentation as required by 29 CFR 1910.134. Provide instruction on the engineering and other hazard control techniques and procedures to be used on this project.
   a. Employee Training: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level in accordance with 40 CFR 763.
4. Permits, Licenses, and Notifications: Notify the local air pollution control district/agency and the the Owner in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M or applicable state and local regulations. Obtain necessary permits or licenses in conjunction with asbestos removal, encapsulation, hauling, and disposal. Post the permit and/or license at the work site, visible from a non-controlled area. Notify the local fire department 3 days prior to removing fire-proofing material from the building including notice that the material contains asbestos.
5. Environment, Safety and Health Compliance: Comply with the applicable requirements of the current issue of 29 CFR 1926.1101, 40 CFR 61-SUBPART A, and 40 CFR 61-SUBPART M or applicable State or local regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable regulations, or referenced documents vary, the most stringent requirement shall apply.
   a. Site Inspection: While performing asbestos engineering control work, the Contractor shall be subject to on-site inspection by the Federal, State, or local regulatory agencies and the Contracting Officer or its designated representative. If the work is found to be in violation of Federal, State, or local regulations or this specification, the Contracting Officer or its representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the. violation shall be at the Contractor's expense.
6. Respiratory Protection Program: Establish and implement a respirator program as required by ANSI 288.2 and 29 CFR 1910.134. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.
   a. Respirator Program Records: Submit records of the respirator program as required by ANSI 288.2 and 29 CFR 1910.134.
7. Contractor/Supervisor (Asbestos Abatement): The Contractor shall be represented on-site by a trained contractor/Supervisor. This person shall be on-site at all times when asbestos work is in progress. The Qualified Person, as defined herein, can be the Contractor/Supervisor.
8. Hazard Communication: Adhere to all parts of 29 CFR 1910.1200 and 29 CFR 1926.59. Provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the site. Review the Asbestos Survey Report(s) provided by the the Owner, if any.
9. Asbestos Hazard Abatement Plan: Submit a detailed plan of the safety precautions such as lockout, tag-out, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan shall be prepared by the Contractor (and reviewed and signed by an asbestos consultant (LAC) licensed according to the Statutes of the State in which the work is to be performed) for review and

recommendation for approval by the the Owner. The plan shall be forwarded to the the Owner for final approval at least 10 days prior to beginning abatement activities. The plan shall include but not be limited to the detailed description of personal protective equipment and work practices to be used including, but not limited to, respiratory protection, type of whole-body protection , the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos encapsulant to be used, locations of local exhaust equipment, planned air sampling strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan shall also include both fire and medical emergency response plans. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work.

10. Testing Laboratory: Submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and/or permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis.
11. Landfill Approval: Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA and State and local regulatory agency(s).
12. Waste Shipment Records/Asbestos Waste Manifest: Submit waste shipment records and/or asbestos manifest records, prepared in accordance with applicable Federal, State, or local regulations, signed and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill, within 3 days after delivery.
13. Negative Exposure Assessment: Submit objective data demonstrating that the method(s) used for the specified non-friable ACM removal does not release airborne concentrations of asbestos fibers exceeding the TWA PEL or excursion limit. This data may be from previous work within the last 12 months or from initial exposure assessments on this project. Data from previous work must have been gathered by the firm employed on this contract, using workers trained to the same level, with the ACM and workplace conditions "closely resembling" the conditions for this contract.
14. Contractor Daily Reports: Prepare a written report for each day that asbestos work is being accomplished. The report should be submitted to the the Owner monthly. The report as a minimum shall include the following, where applicable:
    a. Daily Visual Inspection Reports: Prepare a written report documenting compliance with the Asbestos Hazard Abatement Plan and Federal, State, or local regulations.
    b. Air Sampling Reports: Complete fiber counting within 24 hours of the "time off" of the sample pump. Notify the the Owner immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Sampling results shall be submitted to the the Owner the day following receipt. The affected employees will be provided copies of the results where required by law within 3 working days. These results shall be signed by the air sampler and the testing laboratory employee that analyzed the sample.
    c. Pressure Differential Recordings for Local Exhaust System-Not Used
    d. Asbestos Disposal Quantity Report: The Contractor shall record and report daily the amount of asbestos containing material removed and the amount transported for disposal. Deliver the report for the previous day and cumulative totals with amounts of material removed reported in linear meters or square meters linear feet or square feet as described initially in this specification and the amounts of material transported for disposal reported in cubic meters yards.

D. Submittals
1. Submit the following in accordance with Section "Submittal Procedures."
a. Vacuums and tools
b. Respirators
c. Wetting Agent
d. Safety Data Sheets (SDS) for all materials proposed for transport to the project site
e. Local exhaust system
f. Pressure differential automatic recording instrument
g. Daily Reports
h. Asbestos hazard abatement plan
i. Testing laboratory
j. Training Certificates
k. Landfill approval
l. Employee training
m. Medical certification requirements
n. Waste shipment records/Asbestos waste manifest
o. Respiratory Protection Program
p. Negative Exposure Assessment
q. Local Exhaust system
r. Show compliance with ANSI Z9.2 by providing manufacturers' certifications.
s. Permits, licenses, and Notifications
t. Rental equipment
u. Respirator program records
v. Protective clothing decontamination quality control records
w. Protective clothing decontamination facility notification.

E. Quality Assurance
1. Glovebags-Not Used
2. Rental Equipment: Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.
3. Protective Clothing Decontamination Quality Control Records: Provide all records that document quality control for the decontamination of reusable outer protective clothing.
4. Protective Clothing Decontamination Facility Notification: Submit written evidence that persons who decontaminate, store, or transport asbestos contaminated clothing used in the performance of this contract were duly notified in accordance with 29 CFR 1926.1101.

1.2 PRODUCTS

A. Encapsulants
1. See Division 21 Section “Facility Fire-Suppression Water-Service Piping".

1.3 EXECUTION

A. Equipment
1. Respirators: Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH). Provide personnel engaged in pre-cleaning, cleanup, handling, and removal of asbestos containing materials with the appropriate respiratory protection as specified in 29 CFR 1910.134.
2. Exterior Whole Body Protection
a. Outer Protective Clothing: Provide personnel exposed to asbestos with disposable "non-breathable," or reusable "non-breathable" whole body outer protective clothing, head

coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape. Reusable whole body outer protective clothing shall be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly decontaminated.

b. Work Clothing-Not Used

c. Decontamination of Reusable Outer Protective Clothing: When reusable outer protective clothing is used, transport the double bagged clothing to a previously notified commercial/industrial decontamination facility for decontamination. Perform non-destructive testing to determine the effectiveness of asbestos decontamination. If representative sampling is used, ensure the statistical validity of the sampling results. If representative sampling is used, reject any entire batch in which any of the pieces exceed 40 fibers per square millimeter. Inspect reusable protective clothing prior to use to ensure that it will provide adequate protection and is not or is not about to become ripped, torn, deteriorated, or damaged, and that it is not visibly contaminated. Notify, in writing, all personnel involved in the decontamination of reusable outer protective clothing as indicated in 29 CFR 1926.1101.

d. Eye Protection: Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

3. Warning Signs and Labels: Provide bilingual warning signs printed in English and Spanish at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.

a. Warning Sign: Provide vertical format conforming to 29 CFR 1926.1101 minimum 20 by 14 inches (500 by 355 mm) displaying the following legend in the lower panel:

DANGER
ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY
WEAR RESPIRATORY PROTECTION AND
PROTECTIVE CLOTHING IN THIS AREA

b. Warning Labels: Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

c. Provide the following asbestos labels, of sufficient size to be clearly legible, for display on waste containers (bags or drums) which will be used to transport asbestos contaminated material in accordance with United States Department of Transportation 49 CFR Parts 171 and 172.

NA2212, (WASTE) ASBESTOS, 9, PGIII

4. Vacuums and Tools: Vacuums shall be leak proof to the filter and equipped with HEPA filters. Filters on vacuums shall conform to ANSI Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse.

B. General
1. Pre-Asbestos Work Conference: The Contractor and the Contractor/Supervisor shall meet with the Contracting officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Owners Engineer, the plan will be enforced as if a part of this specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan to allow for free discussion and approval by the Owners Engineer prior to starting work.
2. Asbestos Control Area Requirements: The Contractor shall demarcate the asbestos control area(s) using physical barriers and signs to prevent access by unauthorized personnel. This area is defined by 29 CFR 1926.1101 as the regulated area.
3. Work Procedure: Perform asbestos related work in accordance with 29 CFR 1926.1101, 40 CFR 61-SUBPART M, applicable State or local regulation, and as specified herein. Use wet removal procedures. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, drinking, chewing gum or tobacco, or applying cosmetics shall not be permitted in the asbestos control area(s). Personnel of other trades not engaged in the removal of asbestos containing material shall not be exposed at any time to airborne concentrations of asbestos. If an asbestos fiber release or spill, stop work immediately, correct the condition to the satisfaction of the Owners Engineer, including clean-up and clearance sampling, if appropriate, prior to resumption of work.
4. Furnishings: Furniture will be removed from the area of work by the Owner before asbestos work begins.
5. Pre-cleaning: Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.

C. Removal Procedures: Wet asbestos containing material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 0.15 mm 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 0.15 mm 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Owner's Engineer for approval. Asbestos containing material shall be containerized while wet. At no time shall asbestos containing material be allowed to accumulate or become dry. Handle asbestos containing material as indicated in 40 CFR 61-SUBPART M, applicable State or local regulation, and 29 CFR 1926.1101.
1. Exposed Pipe Insulation Edges-Not Used
2. Negative Pressure Enclosure: Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area.
    a. Personnel/Equipment Decontamination Unit: Provide a temporary facility with a separate equipment/dirty change room and clean change room. Provide a shower that complies with 29 CFR 1926.51 in between the dirty room and clean room for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. All

employees shall shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste or properly decontaminate as specified in the Asbestos Hazard Abatement Plan.

b. Waste Load-Out Unit: Provide a separate temporary area expressly for short-term storage of bagged asbestos containing material that is ready for disposal. The unit shall be the only port used to transfer waste to a truck, dumpster, or other approved on-site storage facility. It shall not be used for personnel egress. A waste load-out unit shall be integral to each negative pressure enclosure.

3. Non-friable Removal Procedures:
   a. Under normal conditions EPA Category II, non-friable asbestos containing materials may not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal; therefore it must be handled in a manner to prevent the release of asbestos fibers. At no time will this material be mechanically chipped, sawed, sanded, or ground.
   b. Prior to beginning removal, establish an Asbestos Control Area and install Critical Barriers as specified elsewhere in this section. Submit a Negative Exposure Assessment which is less than 12 months old to the the Owner for approval or conduct air sampling as specified elsewhere in this section to establish the exposure levels for the exact removal method being used. The Contractor will establish the correct level of Personal Protective Equipment required.
   c. Acceptable methods of removal include, but are not limited to, the use of dry ice, a heat gun or lamp, citrus-based solvents, and hand tools with amended water. Removal shall be accomplished to keep the ACM substantially intact. Breakage into small pieces is an unacceptable work practice. The method shall-be detailed in the Asbestos Abatement Plan and shall not be changed during the removal without Contracting Officer approval.
   d. Upon completion of the removal and clean-up, but prior to removal of critical barriers, the Contractor Testing company shall conduct a visual inspection of all areas affected by the removal. Re-clean as required.

D. Field Quality Control Requirements
1. Visual Inspections: The the Owner will conduct periodic inspections of all areas where asbestos removal and activities are in progress to ensure compliance with the approved Asbestos Hazard Abatement Plan and Federal/State regulatory requirements. This inspection shall include confirmation of proper control/containment/enclosure, worker protection, housekeeping, exhaust equipment operation, decontamination procedures, proper wetting and disposal, and inspection of work progress and work practices. Each activity will be documented as acceptable or noted as unacceptable with justification for the non-compliance.
2. Air Sampling: Sampling of airborne concentrations of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101 and as specified herein. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Air Sampling may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate.
   a. Sampling Prior to Asbestos Work (Not Used)
   b. Sampling During Asbestos Work
      1) The Contractor's testing company shall perform area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Perform area sampling at least once every week close to the work inside the enclosure, outside the personnel/equipment decontamination unit entrance to the enclosure.
      2) If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the fiber release, and notify the the Owner immediately.

Determine by testing if adjacent areas are contaminated. If so the Contractor shall clean the contaminated areas, visually inspect, and sample the areas as specified herein.

3) The Contractor shall conduct personal sampling of at least 25% of the workers engaged in asbestos handling (removal, disposal, transport and other associated work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers at any time exceeds 0.1 fibers per cubic centimeter, notify the PQP immediately, evaluate work practices, and take corrective action to reduce airborne asbestos fibers.

E. Clean-Up And Disposal

1. Housekeeping
   a. Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. All asbestos waste shall be placed in an approved on-site storage facility or transported for disposal daily. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the PQP shall visually inspect the asbestos control area for cleanliness. After final clean-up and acceptable pre-clearance airborne concentrations are attained but before the local exhaust system is turned off and the negative pressure enclosure removed), remove all pre-filters on the building HVAC system and provide new pre-filters.
   b. Dispose of filters as asbestos contaminated materials. Reestablish HVAC,. mechanical, and electrical systems in proper working order.
2. Title to Materials: All waste materials, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified in applicable Federal, State, and local regulations and herein.
3. Disposal of Asbestos
   a. Collect all removed asbestos containing material, contaminated materials, contaminated water, scrap, debris, bags, containers, expendable equipment, and asbestos contaminated clothing which may produce airborne asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 0.15 mm 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 0.15 mm 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag.
   b. Each container or bag shall clearly indicate that the waste generator is the Owner and the development at which the waste is generated, and the Job Order number of the project.
   c. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off the Owner’s property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be coordinated with the the Owner. Procedure for hauling and disposal shall comply with 40 CFR 61-SUBPART M, State, regional, and local standards. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

END OF SECTION 02 82 33 00a

Task	Specification	Specification Description
02 82 33 00	01 22 00 00	No Specification Required
02 82 33 00	02 82 16 00	Engineering Control of Asbestos Containing Materials
02 82 33 00	02 83 19 00	Lead-Based Paint Remediation

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SECTION 02 83 00 00 - LEAD REMEDIATION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for lead paint related abatement procedures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. General Provisions

1. The site of this work will be occupied while work is being done. Perform the abatement work with the least inconvenience to the residents.
2. Take all necessary precautions to protect the property of the the Owner and its residents. Damaged property shall be repaired and restored to its original condition. If the damage is beyond repair, the Contractor shall replace it with new materials to match existing, at the Contractor's expense.
3. Hazardous waste generated during the abatement process (including lead-base paint) when carted away from the developments shall not be transferred from one vehicle to another except at a licensed transfer station.
4. Develop a work plan to be performed as requested by the the Owner. The detailed plan shall include sequencing of abatement work in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
5. The Contractor shall include all supplementary miscellaneous items not specified but implied or required in order to complete the work.
6. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.
7. Make in a timely fashion all applicable and necessary notifications to relevant Federal, State and Local authorities. The Contractor shall indemnify the the Owner and the the Owner's representative from, and pay all claims resulting from failure to adhere to these provisions.
8. the Owner may retain an independent Monitoring Contractor to monitor the abatement contract and conduct all wipe sampling and clearance tests.
9. Contractor performing lead-based paint abatement or renovation activities involving lead-based paint shall be a Certified Lead Abatement Contractor and shall ensure that supervisors and workers are trained and certified by U.S. EPA approved state program or equivalent, to perform lead paint removal operations.
10. Establish and implement a Chemical Hazard Communication Program as required by OSHA regulations 29 CFR 1926.59.
11. Provide workers with a comprehensive medical examination as required by OSHA regulations 29 CFR 1926.62 before exposure to lead contaminated dust. The medical examination shall be conducted to approve use of appropriate respirators and shall include biological monitoring NIOSH/MSHA approved respirators shall be utilized.
12. For employees required to wear a negative pressure respirators: conduct a respirator fit test at the time of initial fitting and at least once every six (6) months thereafter as required by OSHA regulations 29 CFR 1926.62.
13. Determine if any worker will be exposed to lead at or above the action level in accordance with OSHA regulation 29 CFR 1926.62 and 29 CFR 1910.1025. Conduct an exposure assessment to identify the level of exposure a worker would be subjected to without respiratory protection. Assess the exposure level by obtaining personal monitoring samples representative of a full shift of at least an 8-hour TWA.
14. Furnish appropriate respirators approved by NIOSH/MSHA for use in atmospheres containing lead aerosols. Instruct workers in all aspects of respiratory protection. Maintain an adequate supply of HEPA filter elements and spare parts on site for all types of respirators in use.

15. For manual demolition, scraping, sanding, use of heat gun or power tool paint removal with HEPA collection systems, workers shall minimally use the half-mask negative pressure respirator with high efficiency filters (for airborne concentrations not in excess of 500µg/m³).
16. Ensure that work area preparation, work practices, and clean-up procedures comply with these specifications and applicable Federal, State and Local regulations.
17. Notify all applicable agencies five days prior to the date the abatement will begin and provide evidence of notifications to the the Owner at the pre-start meeting.

C. Submissions
1. Within ten (10) consecutive calendar days calculated from the date of the the Owner's Job Order, the Contractor shall tender all required submissions. Six (6) sets of each submission are required. Where physical samples are required two (2) physical samples shall be submitted for each item. In general, items shall include but not be restricted to the following:
   a. Paint remover - corner cutter/Vac-Pac System by Pentek Inc; Decontamination Products Division 1026 Fourth Avenue, Corapolis, PA. 15108. Telephone No. (412) 262-0725 or approved equal.
   b. Description of removal method to be used on each substrate condition including manufacturer's operating instructions and recommendation for equipment usage.
   c. Copies of current training certificates of Staff to be assigned to the contract.
   d. List of three previous lead abatement jobs performed successfully by Contractor and name, address, and telephone number of contact person for verification.
2. In the event that all or any portion of the submitted material is rejected by the the Owner, the Contractor shall tender new submissions. All submissions returned for corrections shall be resubmitted with the required corrections within ten(10) consecutive calendar days calculated from the date of rejection, until final submissions are obtained that require no further correction. In no event shall the Contractor be permitted to tender submissions hereunder beyond twenty (20) days from the the Owner's Job Order, unless duly extended in writing by the the Owner.
3. No work shall begin, nor shall the materials be ordered or delivered to the site until final approval of all submissions.

D. Applicable Regulations
1. 24 CFR Part 35
2. HUD ”Guidelines For the Evaluation and Control of Lead-Based Paint Hazards in Housing”
3. Abatement work shall also be in accordance with applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any State or Local LBP standards. Where there is a conflict between Federal, State or Local regulations, the more stringent requirement shall prevail.
4. OSHA Standards
   a. 29 CFR 1926.20 General safety and health provisions;
   b. 29 CFR 1926.21 Safety training and education;
   c. 29 CFR 1925.25 Housekeeping;
   d. 29 CFR 1926-28 Personal protective equipment;
   e. 29 CFR 1926.51(f) Washing facilities;
   f. 29 CFR 1926.55 Gases, vapors, fumes, dusts, and mists;
   g. 29 CFR 1926.57 Ventilation
   h. 29 CFR 1926.59 Hazardous Communication Standards;
   i. 29 CFR 1926.103 Respiratory protection, and
   j. 29 CFR 1926.62 Lead in Construction
5. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).
6. These Specifications refer to many requirements found in the preceding references but in no way is it intended to cite or reiterate all provisions therein or elsewhere. It is the Contractor's responsibility to obtain a copy, and know, understand and abide by all such regulations, guidelines and common practices.

1.2 PRODUCTS – (not used)

1.3 EXECUTION

A. Abatement
1. Have risk assessment or paint inspection performed by certified risk assessor or a certified inspector technician who is independent of the abatement contractor.
2. Develop a site specific lead hazard control plan, reviewed and signed by an asbestos consultant (LAC) who is licensed in the State in which the work is to be performed, and submit for review and approval to the the Owner.
3. Obtain any necessary building or waste permits, notify local authorities as required by applicable codes and laws.
4. Select specific building component replacement items, enclosure materials, paint removal equipment and/or chemicals, tools, and cleaning supplies. Consider waste management and historical preservation implications of selected treatment.
5. Develop project specific specifications.
6. Schedule other work so that leaded surfaces are not inadvertently disturbed and unprotected workers are not place at risk. Include time for clearance examinations and laboratory dust sample analysis in the scheduling process.
7. Select a certified abatement subcontractor.
8. Conduct a pre-construction conference to ensure that the subcontractor fully understands the work involved.
9. Notify residents of the dwelling and adjacent dwellings of the work and date it will begin. Coordinate this with the the Owner.
10. Correct any existing conditions that could impede the abatement work (i.e. trash removal, structural deficiencies).
11. Post warning signs and restrict entry to work area to authorized personnel. Implement worksite preparation procedures.
    a. Place proper warning signs required by OSHA regulations at all entrances to the work area. Signage shall be minimum of 12" x 20" and shall state the following:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

12. Coordinate test, pilot or sample portion approach to the project with the Owner.
13. Shut-down forced air heating, ventilation and air conditioning systems and cover all vents, diffusers, windows etc., with a single layer six-mil polyethylene sheet secured with duct tape. Exceptions shall be for minor disturbances of area less than 2 square feet and where if vents, diffusers, and windows are more than 5 feet away from surface being disturbed, they need not be covered.
14. Collect preabatement soil samples, which may not have to be analyzed until post abatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed.
15. Cover entrances to the work area with a single layer of 6 mil polyethylene sheets taped to the top and weighted at bottom.
16. Rig a containment non-flammable polyethylene sheet underneath the work area. This containment method should catch all stripped paint for proper disposal.
17. Execute abatement work.
18. Avoid spreading dust and debris outside the work area.
19. Store all waste in a secure area and make sure it is properly labeled with an accumulation start date.
20. Conduct daily and final cleanup.
21. Execute waste disposal procedures.

22. Maintain appropriate records.

B. Paint Removal
1. Do not use the following prohibited paint removal methods:
   a. Dry scraping or sanding (except for limited areas)
   b. Use of heat gun over 1,100°F
   c. Open flame burning or torching
   d. Machine sanding or grinding without HEPA vacuum exhaust tool
   e. Abrasive blasting or sandblasting without HEPA vacuum exhaust tool
   f. Uncontained hydro blasting or high-pressure wash
   g. Use of chemical strippers containing Methylene chloride.
2. Select the appropriate worksite preparation level.
3. For heat gun work, provide fire extinguishers in the work area and ensure that adequate electrical power is available. Use for limited areas only. Train workers to avoid gouging or abrading the substrate.
4. For mechanical removal methods, use tools equipped with HEPA exhaust capability. Be sure workers keep the shroud against the surface being treated. Vacuum blasting and needle guns should not be used on wood, plaster, drywall, or other soft substrates. Observe all manufacturers directions for the amount of vacuum airflow required.
5. For wet scraping, use a spray bottle or wet sponge attached to the scraper to keep the surface wet while scraping. Apply enough water to moisten the surface completely, but not so much that large amounts of water run onto the ground or floor. Do not moisten areas near electrical circuits.
6. For chemical paint removers, determine if the building component can be removed and stripped offsite. Offsite stripping is generally preferred to onsite paint removal. Observe all manufacturers' directions for use of paint removers.
7. For offsite stripping, determine how to remove the component. Score the edges with a knife or razor blade to minimize the damage to adjacent surfaces. Punch or tag the building component, if similar building components are also being stripped offsite (i.e. doors). This will ensure that the individual component is reinstalled in the same location. Inform the offsite paint remover that the lead-based paint component is present for shipping. Wrap the component in plastic and send to the offsite stripping location. Clean all surfaces before reinstallation and remove any lead residue by HEPA vacuuming all surfaces, cleaning with other lead-specific cleaners, or phosphate detergents, and HEPA vacuuming again.
8. For onsite paint removal, first test the product on a small area to determine its effectiveness. Chemical paint removers may not be effective or desirable on exterior, deteriorated wood surfaces, aluminum, and glass. Provide neoprene, nitrile, rubber, or polyvinyl chloride (PVC) gloves (or other type of glove recommended by the manufacture); face shields; respirators with combination filter cartridges for lead dust and organic vapors(if appropriate); and chemically resistant clothing. Be sure to select the right type of organic vapor filter cartridge, gloves, and clothing for the specific chemical being used. Portable eyewash stations capable of providing a 15-minute flow must be on-site. Apply the chemical and wait the required period of time. Securely store chemical s overnight. For caustic chemical paint removers, neutralize the surface before repainting using glacial acetic acid (not vinegar). Repaint.
9. Make sure all debris is caught in the containment sheet for proper disposal.
10. Mark and legally dispose of waste in accordance with all applicable Federal, State and Local regulations. Most wastes from paint removal projects, such as paint chips and paint remover sludge, will need to be managed as hazardous waste.
11. Conduct clean-up
12. Have a certified risk assessor or inspector technician conduct a clearance examination and provide documentation and a Statement of Lead-Based Paint Compliance.

C. Building Component Replacement
1. Prepare work area by selecting proper worksite preparation level.
2. Prepare the hazardous material building component for removal. Turn off and disconnect any electrical circuits inside or near the building component to be removed.

3. Lightly mist the component to be removed (unless electrical circuits are located nearby).
4. Score all painted seams with a sharp knife.
5. Remove any screw, nails, or other fasteners.
6. Use flat pry instrument and hammer to pry component from the substrate.
7. Remove or bend back all nails.
8. Wrap and seal all bulk components in plastic and take them to a covered truck or secured waste storage area along a pathway covered in plastic. Shovel any debris. Dispose of properly.
9. HEPA vacuum any dust or chips in the area where the component was located.
10. Conduct cleaning and clearance activities.

D. Soil and Exterior Dust Abatement
1. Determine if soil lead hazard exists. For hazard to exist, a total of at least 9 square feet of soil in a single yard or area must be bare and soil concentrations must exceed 2,000µg/gram lead for the yard or building perimeter or 400µg/gram of lead for small, high-contact play areas (pending the development of an EPA soil standard). Bare soil above these levels shall be treated by either interim controls or abatement. Soil abatement is most appropriate when levels of lead are extraordinarily high (greater than 5,000µg/gram lead) and when use patterns indicate contact frequency and exposure will be high.
2. Collect Preabatement soil samples to determine baseline levels. These samples need not be analyzed if post abatement samples are below applicable clearance levels.
3. Determine the method of soil abatement (soil removal and replacement, soil cleaning, or paving). Soil cultivation (rototilling or turning over the soil) is not permitted.
4. If paving, use a high quality concrete or asphalt. Observe normal precautions associate with traffic load weight and thermal expansion and contraction. Obtain necessary permits. Keep soil cultivation to a minimum.
5. If removing and replacing soil.
    a. Determine if waste soil will be placed in an offsite burial pit. Prepare vehicle operation and soil movement plan. Test new replacement soil (should not contain more than 200 µg/gram lead).
    b. Contact local utilities to determine location of underground utilities including water, gas, cable TV, electric, telephone, and sewer. Mark all locations to be avoided
    c. Remove fencing, if necessary to allow equipment access and define set limits with temporary fencing, signs, or yellow caution tape.
    d. Tie and protect existing trees, shrubs, and bushes.
    e. Have enough tools to avoid handling clean soil with contaminated tools.
    f. Remove soil.
    g. Clean all walkways, driveways, and street areas near abatement area.
    h. Replace soil at proper grade to allow drainage. Replacement soil should be at least 2 inches above existing grade to allow for settling.
    i. Install new soil covering (grass or sod) and maintain it through the growing season.
    j. Determine if soil waste is hazardous and manage it accordingly
    k. Conduct clean-up and clearance.
    l. Provide walk-off doormats.
    m. Maintain proper documentation.

E. Encapsulation
1. Determine if the applicable regulations aloe encapsulates to be used. Do not encapsulate the following surfaces:
    a. Friction surfaces, such as window jambs and door jambs.
    b. Surfaces that fail patch tests.
    c. Surfaces with substrates or existing coatings that have a high level of deterioration.
    d. Surfaces I which there is a known incompatibility between two existing paint layers.
    e. Surfaces that cannot support the additional weight stress of encapsulation due to existing paint thickness.
    f. Metal surfaces that are prone to rust or corrosion.
2. Conduct field tests of surfaces to be encapsulated for paint film integrity.

3. Consider special use and environmental requirements (i.e. abrasion resistance and ability to span base substrate cracks).
4. Provide to the the Owner encapsulant test data provided by the manufacturer.
5. Conduct at least one test patch on each type of building component where the encapsulant will be used. Report the results to the the Owner.
6. For both nonreinforced and reinforced coatings, use a 6" x 6" test patch area. Prepare the surface in the manner selected to complete the job. Prepared surfaces for patch testing should be at least 2" larger in each direction than the patch area.
7. For fiber-reinforced wall coverings, use 3" x 3" patch. For rigid coatings that cannot be cut with a knife, use soundness test. For all encapsulants, carry out the appropriate adhesion tests.
8. For liquid coating encapsulants, allow coating to cure, then visually examine it for wrinkling, blistering, cracking, bubbling, or other chemical reaction with the underlying paint.
9. Record results of all patch tests and provide to the the Owner.
10. Implement proper work site preparation level.
11. Repair all building components and substrates as needed (i.e. caulk cracks and repair sources of water leaks).
12. Prepare surfaces. Remove all dirt, grease, chalking paint, mildew and other surface contaminants, remnants of cleaning solutions, and loose paint. All surfaces should be deglossed, as needed.
13. Ventilate the contaminated area whenever solvents or chemicals are used.
14. During encapsulant application or installation, monitor temperature and humidity. For liquid coatings monitor coating thickness to ensure that the encapsulant manufacturer's installation/application specifications are followed.
15. Conduct clean up and clearance.
16. Provide the the Owner information on how to care for the encapsulation system properly.
17. Maintain records on the exact detailed locations of encapsulant applications, patch test specifications and results, product name, subcontractor, date of application, a copy of the product label and Safety Data Sheet (SDS) for the product and provide to the the Owner.

F. Enclosure
1. Stamp, label or stencil all lead-based painted surfaces that will be enclosed with a warning approximately every 2 feet both horizontally and vertically on all components. The Warning shall read "**Danger Lead-Based Paint**". Deteriorated paint should not be removed from the surface to be enclosed.
2. Select the proper worksite preparation level.
3. Attach a durable drawing to the utility room closet showing where lead-based paint has been enclosed in the dwelling.
4. An independent inspector or technician or risk assessor should evaluate the integrity of the enclosure.
5. Repair any unsound substrates and structural members that will support the enclosure, if necessary.
6. Utilize appropriate enclosure material (drywall or fiberboard, wood paneling, laminated products, ridged tile and brick veneers, vinyl, aluminum m, or plywood).
7. Install extension rings for all electrical switches and outlets that will penetrate the enclosure.
8. If enclosing floors, remove all dirt with a HEPA vacuum to avoid small lumps in the new flooring.
9. Seal and back-caulk all seams and joints. Back-caulk means applying caulk to the underside of the enclosure.
10. When installing enclosure directly to painted surfaces, use adhesive and then anchor with mechanical fasteners (screws or nails).
11. Conduct clean up and clearance activities.
12. Maintain proper records and submit a Statement of Lead-Based Paint Compliance.

G. Final Cleaning Procedures
1. Use the following step-by-step procedures

a. Assign responsibilities to specific workers for cleaning and for maintaining the cleaning equipment.
b. Have sufficient cleaning equipment and supplies before beginning work.
c. If contamination is extensive, conduct precleaning of the dwelling unit.
d. Conduct ongoing cleaning during the job, including regular removal of large and small debris and dust. Decontamination of all tools, equipment and worker protection gear is required before it leaves contaminated areas. Electrical equipment should be wiped and high-efficiency particulate air (HEPA) vacuumed, not wetted down, to minimize electrocution hazards.
e. Schedule sufficient time (usually 30 minutes to an hour) for complete daily cleaning, starting at the same time near the end of every workday after lead hazard control activity has stopped.
f. For final cleaning, wait at least 1 hour after active lead hazard control activity has ceased to let dust particles settle.
g. Use a vacuum cleaner equipped with a HEPA exhaust filter. HEPA vacuum all surfaces in the room (ceilings, walls, trim, and floors). Start with the ceiling and work down, moving toward the entry door. Completely clean each room before moving on.
h. Wash all surfaces with lead-specific detergent, high-phosphate detergent, or other suitable cleaning agent to dislodge any ground-in contamination, then rinse. Change the cleaning solution after every room is cleaned.
i. Repeat step g above. To meet clearance standards consistently, a HEPA vacuum, wet wash, and HEPA vacuum cycle is recommended. For interim control projects involving dust removal only, the final HEPA vacuuming step is usually not needed. Other cleaning methods are acceptable, as long as clearance criteria are met and workers are not over exposed.
j. After final cleaning perform visual examination to ensure that all surfaces requiring lead hazard control have been addressed and all visible dust and debris have been removed. Record findings and correct any incomplete work.
k. If other construction work will disturb the lead-based paint surfaces, it should be completed at this point. If those surfaces are disturbed, repeat the final cleaning step after construction work has been completed.
l. Paint and otherwise seal treated surfaces and interior floors.
m. Conduct clearance examination.
n. If clearance is not achieved, repeat final cleaning.
o. Continue clearance testing and repeated cleanings until dwelling unit achieves compliance with all clearance standards. The cost of repeated cleaning, after failure to achieve clearance is to be borne by the contractor.
p. Do not allow residents to enter work area until final cleaning is completed and clearance is established.
q. Cleaning equipment list is as follows:
    1) HEPA Vacuums
    2) Detergent
    3) Waterproof gloves
    4) Rags
    5) Sponges
    6) Mops
    7) Buckets
    8) HEPA vacuum attachments (crevice tools, beater bar for cleaning rugs)
    9) 6-mil plastic bags
    10) Debris containers
    11) Waste water containers
    12) Shovels
    13) Rakes
    14) Water-misting sprayers
    15) 6-mil polyethylene sheeting (or equivalent)

2. Order of execution for final cleaning steps should be as follows:

a. As the first stage in final cleaning, floor plastic shall be misted and swept.
b. Upper level plastic, such as on cabinets and counters should be removed first, after it has been misted and cleaned. All plastic should be carefully folded from the corners/ends to the middle to trap any remaining dust. Next remove both layers of plastic from the floor.
c. Plastic sheets used to isolate contaminated rooms from noncontaminated rooms should remain in place until after cleaning and removal of other plastic sheeting, these sheets may then be misted, cleaned and removed last.
d. Removed plastic should be placed into double 4-mil or single 6-mil plastic bags, or plastic bags with equivalent (or better) performance characteristics, which are sealed and removed from the premises. As with daily cleanings, this plastic removal process usually requires workers to use protective clothing and respirators.
e. After plastic has been removed from the contaminated area, the entire area should be cleaned using the HEPA/wet wash/HEPA cycle.

H. Waste Testing And Disposal

1. General: All materials, whether hazardous or non-hazardous shall be properly disposed of. the Owner may hire an independent Monitoring Consultant to perform TCLP test to determine which of the wastes are hazardous. Contractor shall cooperate in this test. If less than 100kg (200 lbs) or 1/2 of a 55 gallon drum of hazardous waste per month will be generated, it is considered "conditionally exempt" abatement waste, and may be managed as solid non-hazardous waste. The RCRA hazardous waste manifest is not required when shipping this waste to an offsite disposal facility.
2. Separate Abatement Waste into The Following Four Categories:
   a. Category I. Low lead waste (typically non-hazardous) e.g. Filtered personal and commercial wash water.
   b. Category II. Architectural components - (painted finish carpentry items) e.g. Doors, windows, window trim and sills, baseboards, railings, moldings. (May do a TCLP to determine if they are hazardous).
   c. Category III. Concentrated lead waste e.g. sludge from stripping, lead-base paint chip and dust, HEPA vacuum debris and filter, unfiltered wash waste, any waste included in EPA's list of hazardous waste.
   d. Category IV. Material that cannot be determined to be either hazardous or non-hazardous must be tested by TCLP.

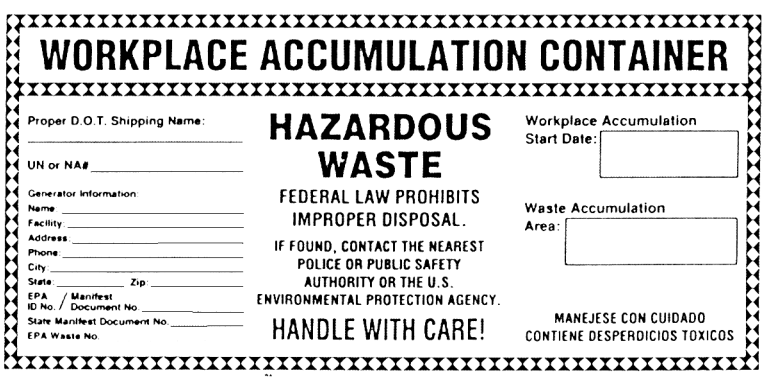
   If the hazardous waste generated is greater than 100kg per month, dispose according to the referenced guidelines and RCRA hazardous waste management requirements including those listed below.
3. Disposal Requirements: Contact the regional EPA, state, local and all other pertinent authorities to determine lead-based paint debris disposal requirements. Comply with requirements of the Resource Conservation and Recovery Act (RCRA) and with applicable federal, state, county, or local waste requirements.
4. EPA ID Numbers: Obtain a Generator RCRA Hazardous Material ID number and coordinate this action through the State and secure any additional number as required.
5. Storage Requirements: Keep all hazardous items in a secure area or lockable container that is inaccessible to all persons other than the Contractor's personnel. Label all hazardous waste "Hazardous Waste" with the date that the Contractor began to collect the waste in that container. Keep hazardous and non-hazardous waste in separate containers. Until TCLP testing is completed, considered all items hazardous and store in a secured area or lockable container.
6. Waste Transportation: Transport hazardous waste using a RCRA/DOT/EPA certified Hazardous Waste Transporter. Submit names and qualifications of certified transporter/hauler for the Owner approval. The Contractor shall be responsible for all actions of the waste hauler as pertaining to waste removal and disposal under these procedures and all EPA, DOT and other applicable regulations.
7. Disposal Facility: Supply documents that detail the site(s) to be used for ultimate disposal. Submit documents from these sites proving that they are licensed/permitted to accept such waste and shall accept the waste proposed by the Contractor for treatment or ultimate disposal.

8. Waste Containers: Comply with EPA and DOT regulations for waste containers. Contact the state and local authorities to determine their criteria for containers. In the case of any conflict in regulations, the more stringent shall apply.
9. Emergencies: Contact local fire, police, hospitals or local emergency response teams and inform them of the type of hazardous waste activity and ask for assistance in the event of any accident. Additionally, the container shall provide the following:
    a. Keep and properly maintain a suitable fire extinguisher(s) on site.
    b. Have a immediate means of communication with the regulatory agency in the event of an emergency.
    c. Keep a list of phone numbers of regulatory agencies on site.
    d. Appoint an emergency coordinator and ensure the coordinator is on site to supervise emergency procedures to be carried out in the event of an emergency.
    e. Keep and maintain a "right to know" manual that is in an easily accessible location and in an area that is known to all employees.
10. Transporting Waste: Provide certifications that the transporter is registered with the U.S. Department of Transportation is required by 49 CFR Part 107(a) transport hazardous waste.
    a. Provide certifications that each vehicle dedicated to haul hazardous waste has been assigned a "U.S. DOT Hazardous Material Registration Number" as required by 49 CFR Part 107.
    b. Be responsible for all other applicable permits pertaining to hauling, transport, reduction, and disposal of hazardous waste as they may apply to this project.
    c. Vehicle: Ensure that all non-hazardous waste is transported in covered vehicles to a landfill, or lined landfill, if required.
    d. Container Handling: Carefully place the containers into the truck or dumpster used for disposal. At no time shall debris or containers be thrown or dropped.
    e. Liquid Wastes: Contain and properly dispose of all liquid wastes, including lead-contaminated wash water.
    f. Containers: HEPA vacuum the exterior of all waste containers prior to removing the waste containers from the work area. Wet wipe the containers to ensure that there is no residual contamination. Then move containers out of the work area into the designated storage area.

I. Clearance
1. Clearance on all abatement projects must be done by an independent certified risk assessor or inspector technician. Follow all jurisdictional law with regard to licensure requirements for personnel conducting clearance activities.
2. Clearance step-by-step procedures are as follows:
    a. Finish the lead hazard control clean-up effort. Seal floors before clearance (if necessary).
    b. Wait 1 hour to allow any airborne dust to settle. Do not enter work area during that hour.
    c. Conduct visual examination
        1) Determine if all required work has been completed and all lead-based paint hazards have been controlled.
        2) Determine if there is visible settled dust, paint chips, or debris in the interior or around the exterior.
    d. Complete the Visual Clearance Form required by the the Owner; if all work is not completed inform the the Owner and order completion of the work and repeat cleanup, if necessary.
    e. Conduct clearance dust sampling of the floors, interior window sills, and window troughs using approved protocol.
    f. Conduct soil sampling if bare soil is present that was not sampled previously, or if exterior paint work was completed as part of the lead hazard control effort. Whenever exterior work has been don, it may be necessary to take samples from the soil that is not bare to determine if contamination has occurred. If results are above 1,000 µg/g (or 400 µg/g in high contact play area), compare the results to baseline soil sampling results to determine what additional measures are needed.
    g. Complete the Dust and Soil Sampling Clearance Form required by the the Owner.

h. Submit samples to a U.S. Environmental Protection Agency (EPA) recognized laboratory participating in the National Lead Laboratory Accreditation program (NLLAP) for analysis.
i. Interpret results by comparing them to Interim Clearance Standards as listed below:
   1) Floors 400 µg/ft2
   2) Window sills 250 µg/ft2
   3) Window Troughs 800 µg/ft2
   4) Soils (Play area with children under 6 years of age) 400 µg/gram
j. If clearance is achieved go to step N.
k. Order repeated cleanings or soil treatments if results are above applicable standards. Clean all surfaces the sample represents.
l. Continue sampling and repeated cleanings until the dwelling achieves compliance with all applicable clearance standards.
m. Complete any related construction work that does not disturb a surface with lead-based paint (all work that does disturb painted surfaces or that could generate lead dust should be completed as part of the lead hazard control effort).
n. Issue any necessary statements of lead-based paint compliance or releases and maintain appropriate records.

J. Labels
1. Use the following labels on drums used for disposal.



WORKPLACE ACCUMULATION CONTAINER

Proper D.O.T. Shipping Name: _____

UN or NA# _____

Generator Information:
Name: _____
Facility: _____
Address: _____
Phone: _____
City: _____
State: _____ Zip: _____
EPA ID No. / Manifest Document No. _____
State Manifest Document No. _____
EPA Waste No.

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.

IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

HANDLE WITH CARE!

Workplace Accumulation Start Date: _____

Waste Accumulation Area: _____

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K. Disposal of lead-based paint waste.

1. Follow the RCRA and HUD recommended practices as defined in the table below:

Waste Management Practices	Category I: Low Lead Waste	Category II: Architectural Components	Category III: Concentrated Lead Waste	Category IV: Other waste
RCRA Requirements	Manage as nonhazardous Waste	Depending upon knowledge or TCLP testing results, manage as solid hazardous or nonhazardous waste	If more than 100 kg/ month, manage as hazardous waste. If less than 100 kg/month manage as solid waste.	Use TCP to determine if waste is hazardous.
HUD Recommended Practices	Applicable	Applicable, if knowledge or TCLP testing indicates that it is nonhazardous.	Applicable if less than 100 kg/month otherwise subject to full RCRA regulations	Only applicable if TCLP testing shows waste is nonhazardous
Wrapped in plastic; seal all seams with tape (if acceptable to the disposal facility).	X	X	X	X
Stored in designated, secure area.	X	X	X	X
Covered During Transport	X	X	X	X
Prohibit cutting/breaking outside work area.	X	X	X	X
Cover ground with 6-mil plastic if handling outside.	X	X	X	X
Prohibit disposal in solid waste incinerators and reuse recycling for mulch	X	X	X	X
Recommended disposal in State licensed/permitted	X	X	If appropriate.	X

solid waste landfill.				

L. Safety Requirements
1. To protect the health and safety of all persons involved, it is of the utmost importance that deleading is safely and correctly done in a timely manner. The following specific safety requirements are the responsibility of the Deleading Contractor.

K. General Safety:
1. General
   a. NO ONE is to be allowed in the work area without an approved respirator except for methods that have been documented not requiring a respirator.
   b. Each work area must be sealed from the remainder of the dwelling by taping plastic sheets (6 mil thick). Work areas must remain sealed off until both work and clean-up are completed.
   c. Cover all floors, carpets, furniture and appliances with 6 mil plastic within the work area. Use automotive masking tape (2 inches wide) to seal all edges and seams.
   d. Make certain all electrical connections are properly grounded.
   e. At least three days prior to the start of any deleading work, post appropriate warning signs at all entrances and exits of work areas and leave in place until all clearance testing indicates that these areas are safe for re-occupancy. The signs must include the following phrase: "CAUTION LEAD HAZARD-KEEP OUT". Post bilingual signs when necessary.
2. Worker Safety: The Deleading Contractor shall take the following minimum precautions to protect the health of all individuals involved in the deleading process.
   a. Pre-Abatement Medical Exam: Each employee shall undergo a medical examination to determine both respiratory fitness capability and also pre-existing/current blood lead level. Said results shall be provided to the employee and also to the Owner within 3 days of receipt of same, and in all cases, prior to employee's commencement to active abatement. Records of same are required to be kept by the Contractor for 40 years.
   b. Medical Surveillance is the monitoring of worker blood levels. It is required that the Contractor have blood level monitoring of all active abatement and clean-up workmen and on-site supervisors performed and said results provided to the Owner.
      1) Before assignment to active abatement activity for each worker.
      2) 30 days after active abatement has begun.
      3) At least every two months during the first six months and every six months throughout the deleading job.
      4) At least every two months for each employee whose blood lead analysis indicated a blood lead level at or above 25 micrograms per deciliter. (20 micrograms per deciliter for women of child bearing age).
      5) At termination of employment.
      6) Contractor shall reassign any employee whose blood lead has reached 25 µg/dl (20 µg/dl for women of child bearing age) to a job function deemed safe from lead exposure. Said employee shall remain away from active abatement until such time as 2 consecutive months' blood tests indicate µg/dl below 20 µg/dl.
   c. Respiratory Protection Programs must be established by the Contractor in accordance with OSHA regulations and qualitative respirator fit testing must be conducted daily by the on-site supervisor. Medical examinations must be performed by a physician prior to fit testing and at anytime when a worker demonstrates any difficulty breathing during the use of or the fit testing of respirators. The following are minimal acceptable respiratory protection program requirements as set up and administered by the Contractor:
      1) Written standard operating procedures which oversees the selection and use of respirators.
      2) Selection of respirators on the basis of hazards to which the worker is exposed.
      3) Worker training on the limitations and use of respirators (includes fit testing).
      4) Individual workers assigned respirators for their exclusive use only.

5) Daily cleaning and disinfecting of respirators.
6) Proper storage of all respirators.
7) Proper inspection of all respirators for wear and tear.
8) Continual surveillance of work area conditions and level of worker exposure or stress.
9) Use of approved respirators only, modified as needed by the weekly exposure monitoring results.
10) Supply weekly report covering items 1-9 to the Owner or its Lead Consultant.

d. Exposure Monitoring is the measured concentration of lead in the workers breathing zones. The Contractor shall perform personnel monitoring during active abatement using the NIOSH 7072 method and-shall be responsible for:
1) Monitoring the level of worker protection needed during the abatement process;
2) Evaluating, modifying and improving any engineering and work practice control(s) as needed;
3) Evaluating each employee's personal quality of work and any need for additional worker training or safety instruction;
4) Providing the Owner results of all personnel monitoring tests within 10 days of testing; and
5) Providing half-face APR respirators with HEPA filters unless said monitoring test results dictate differently. OSHA guidelines shall be used to determine respirator PEL protection factors.

e. Protective Clothing Equipment must be provided to all workers to help assure that lead dust is contained to the work areas. The following must be supplied/enforced by the Deleading Contractor:
1) Full body protective clothing and shoe covers of appropriate sizes on a daily basis or as needed.
2) Clean changing areas separated from the dirty/contaminated clothes storage area.
3) Water and wash facilities for washing of hands and face and shower facilities if deemed necessary by the Owner's Lead Advisor.
4) Instructing worker on proper maintenance of clothing and equipment.
5) Proper disposal of disposable clothing and proper permanent work clothes.
6) Enforcing the removal of protective clothing at the end of each work day and before eating, drinking and smoking.
7) Enforcement of the removal of protective shoe covers before leaving work area.

3. Contractor/Worker Daily Safe-Work Procedures
a. Daily Start-Up:
1) Workers to put on protective gear prior to entering work areas.
2) All garment seams to be sealed with duct tape.
3) All non-working garments must be stored in designated changing area.
4) Respirators, as required, must be properly fitted before entering work area. Perform qualitative fit test.

b. Temporary depart:
1) All protective clothing to be HEPA vacuumed while still being worn.
2) All shoe covers to be removed and left in the work area (immediate departure upon removing).
3) Remove all protective gear in designated "contaminated" changing area before eating, drinking, and smoking or before leaving work site.
4) Wash hands and face.
5) Clean respirators.

c. Daily Shut-Down:
1) Dispose of protective clothing with abatement waste by sealing in a 6 mil poly bag.
2) Laundered clothes must be placed in closed container.
3) Wash hands and face.
4) Shower if facilities allow and circumstances dictate.
5) Clean all protective gear (respirators included).

4. Tenant's Safety: Temporary relocation of the tenants is necessary if the lead paint surface is broken. Temporary relocation of the tenants and their belongings is the responsibility of the Owner. However, the Contractor has the joint responsibility to administer and enforce the following safety practices on behalf of the occupants:
   a. Adults
      1) NO OCCUPANT is allowed to enter the work area during paint removal and initial clean-up. A three day clean-up and settlement period may be imposed depending upon the abatement procedures used, at the discretion of the Owner or their Lead Consultant.
      2) the Owner shall notify all occupants in writing when they are allowed to return to their post-abated residence. Contractor shall abide by these notices.
      3) Every resident who has received prior notice of abatement is responsible for placing all personal items (clothing, dishes, linens, etc.) in closed, easy to handle containers; and move such items to the center of each room as requested.
      4) As long as visible dust remains, occupants may not occupy dwelling, and all surfaces within the dwelling must be re-washed with trisodium phosphate and HEPA vacuumed by deleading contractor.
      5) Persons reoccupying dwellings following abatement are required to report any visible dust or debris to the Owner immediately for additional Contractor clean-up.
   b. Pregnant Women and Children
      1) Absolutely no pregnant women nor children under the age of twelve years of age may be allowed in the building while any part of the abatement process is going on.

END OF SECTION 02 83 00 00

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SECTION 02 83 19 00 - LEAD-BASED PAINT REMEDIATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the removal and disposal of lead-based or lead-containing paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions
1. Action Level: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in an occupational/industrial environment.
2. Area Sampling: Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.
3. Competent Person (CP): As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. An industrial hygienist or safety professional certified for comprehensive practice by the American Board of Industrial Hygiene or by the Board of Certified Safety Professionals is the best choice.
4. Contaminated Room: Room for removal of contaminated personal protective equipment (PPE).
5. Decontamination Shower Facility: That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.
6. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.
7. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.
8. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps.
9. Lead-Based Paint (LBP): Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.
10. Lead-Based Paint Hazard (LBP Hazard): Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.
11. Lead-Containing Paint (LCP): Lead-based paint or other similar surface coating containing lead or lead compound in excess of 0.06 percent by weight of the total nonvolatile content of the paint.
12. Lead Control Area: An enclosed area or structure, constructed as a temporary containment equipped with HEPA filtered local exhaust, which prevents the spread of lead dust, paint chips, or debris existing as a condition of lead-based paint removal operations. The lead control area is also isolated by physical boundaries to prevent unauthorized entry of personnel.
13. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a work day, the PEL shall be determined by the following formula:
PEL (micrograms/cubic meter of air) = 400/No. hrs. worked per day.
14. Personal Sampling: Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches (150 to 225 mm) and centered at the nose or mouth of an employee.

15. Physical Boundary: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside boundary."

C. Submittals: Submit the following:
   1. Product Data:
      a. Vacuum filters
      b. Respirators
   2. Test Reports
      a. Sampling results
      b. Assessment data report
   3. Certificates
      a. Qualifications of CP
      b. Testing laboratory</SUB> qualifications
      c. Third party consultant qualifications
      d. Lead-Based Paint/Lead-Containing Paint Removal Plan including CP approval (signature, date, and certification number)
      e. Rental equipment notification
      f. Respiratory protection program
      g. Hazard communication program
      h. EPA approved hazardous waste treatment or disposal facility for lead disposal
      i. Hazardous waste management plan
      j. Vacuum filters
   4. Manufacturer's Instructions
      a. Chemicals and equipment
      b. Materials
      c. Safety data sheets for all chemicals
   5. Closeout Submittals
      a. Completed and signed hazardous waste manifest from treatment or disposal facility
      b. Certification of medical examinations
      c. Employee training certification

D. Qualifications Of CP
   1. Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained and licensed and certified in accordance with Federal, State, and local laws.

E. Third Party Consultant Qualifications
   1. Submit the name, address, and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead in dust or soil sampling. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

F. Testing Laboratory
   1. Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe and soil sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis.

G. Lead-Based Paint/Lead-Containing Paint Removal Plan (LBP/LCPRP)

1. Submit a detailed job-specific plan of the work procedures to be used in the removal of LBP/LCP. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air and baseline lead dust/soil concentrations are not reached or exceeded outside of the lead control area. Include site preparation and cleanup procedures. Include occupational and environmental sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan.

H. Occupational And Environmental Sampling Results
1. Submit occupational and environmental sampling results to the the Owner within three working days of collection, signed by the testing laboratory responsible official, the employee that performed the sampling, and the CP.
   a. The sampling results shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead.
   b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62.
   c. The initial monitoring shall determine the requirements for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCP) in accordance with 29 CFR 1926.62.

I. Occupational And Environmental Assessment Data Report:
1. Some LBP/LCP removal work may not require full implementation of the requirements of 29 CFR 1926.62. Based on the experience of the Contractor and/or the use of a specific process or method for performing the work, the Contractor may be able to provide historic data (previous 12 months) to demonstrate that airborne exposures are controlled below the action level. Such methods or controls shall be fully presented in the LBP/LCPRP. To reduce the full implementation of 29 CFR 1926.62, the Contractor shall provide documentation in an Assessment Data Report.
2. Submit occupational and environmental assessment report to the the Owner prior to start of work, signed by the testing laboratory responsible official, and the CP.
   a. Submit a report that supports the determination regarding the reduction of the need to fully implement the requirements of 29 CFR 1926.62 and supporting the LBP/LCP. The exposure assessment shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.
   b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62 with a complete process description in supporting a negative assessment.
   c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCPRP) in accordance with 29 CFR 1926.62.

J. Quality Assurance
1. Medical Examinations: Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103.

a. Medical Records: Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.
b. Medical Surveillance: Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62.

2. Competent Person (CP) Responsibilities
   a. Certify training as meeting all federal, State, and local requirements.
   b. Review and approve lead-based paint/lead-containing paint removal plan for conformance to the applicable referenced standards.
   c. Continuously inspect lead-based paint removal work for conformance with the approved plan.
   d. Perform air and wipe sampling.
   e. Ensure work is performed in strict accordance with specifications at all times.
   f. Control work to prevent hazardous exposure to human beings and to the environment at all times.
   g. Certify the conditions of the work as called for elsewhere in this specification.
3. Training: Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations.
   a. Training Certification: Submit a certificate for each employee, signed and dated by the approved training source, stating that the employee has received the required lead training.
4. Respiratory Protection Program
   a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62.
   b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.
5. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.
6. Hazardous Waste Management: The Hazardous Waste Management Plan shall comply with applicable requirements of federal, State, and local hazardous waste regulations and address:
   a. Identification and classification of hazardous wastes associated with the work.
   b. Estimated quantities of wastes to be generated and disposed of.
   c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact. Furnish two copies of EPA, or State and local hazardous waste permit applications or permits or manifests, as required, and EPA Identification numbers.
   d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
   e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
   f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.
   g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
   h. Unit cost for hazardous waste disposal according to this plan.
7. Environmental, Safety and Health Compliance: In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the the Owner for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

8. Pre-Construction Conference: Along with the CP, meet with the the Owner to discuss in detail the hazardous waste management plan and the lead-based paint/lead-containing paint removal plan, including work procedures and precautions for the removal plan.

K. Equipment
1. Respirators: Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.
2. Special Protective Clothing: Furnish personnel who will be exposed to lead-contaminated dust with proper disposable uncontaminated, reusable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.
3. Rental Equipment Notification: If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the the Owner.
4. Vacuum Filters: UL 586 labeled HEPA filters.
5. Equipment for Owner's Personnel: Furnish the the Owner with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. Respiratory protection for the the Owner will be provided by the Owner.

L. Removal
1. Title to Materials: Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Division 2 Section "Selective Structure Demolition", "Structure Demolition", except as specified herein.

1.2 PRODUCT

A. Chemicals
1. Submit applicable Safety Data Sheets for all chemicals used in paint removal work. Use the least toxic product approved by the the Owner.

B. Materials
1. The soluble metal content and the total metal content shall not exceed values which would cause a material to be classified as a hazardous waste.

1.3 EXECUTION

A. Protection
1. Notification: Notify the the Owner 20 days prior to the start of any paint removal work.
2. Lead Control Area Requirements
   a. If LBP will be removed by means which will not likely create airborne, lead-containing dust (such as careful wet scraping or chemical stripping), establish a lead control area by situating critical barriers and physical boundaries around the area or structure where LBP/LCP removal operations will be performed.
   b. If removal practice will create airborne, lead-containing dust (such as sanding, abrasive blasting, thermal cutting, demolition, or needle gun use), utilize full containment procedures - Contain removal operations by the use of critical barriers and HEPA filtered exhaust **OR** a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust if required by the CP, **as directed**. For containment areas larger than 1,000 square feet (100 square meters) install a minimum of two 18 inch (450 mm) square viewing

ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.

3. Protection of Existing Work to Remain: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.
4. Boundary Requirements: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
   a. Physical Boundary: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
   b. Warning Signs: Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.
5. Furnishings:
   a. The Owner will remove furniture and equipment from the building before lead-based paint removal work begins.
      OR
      Furniture and equipment will remain in the building. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the the Owner.
      OR
      Existing furniture and equipment is lead contaminated, decontaminate, dispose of as lead contaminated waste.
6. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil (0.15 mm) plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.
7. Decontamination Shower Facility: Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.
8. Eye Wash Station: Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.
9. Mechanical Ventilation System
   a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.
   b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.
   c. Vent local exhaust outside the building only and away from building ventilation intakes.
   d. Use locally exhausted, power actuated, paint removal tools.
10. Personnel Protection: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

B. Work Procedures: Perform removal of lead-based paint in accordance with approved lead-based paint/lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, State, and local requirements.
   1. Personnel Exiting Procedures: Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.
b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.
c. Shower **OR** Wash hands and face at the site, **as directed**, don appropriate disposable or uncontaminated reusable clothing; move to an appropriate facility; shower.
d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

2. Air and Wipe Sampling
   a. Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.
      1) The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal work to ensure that the requirements of the contract have been satisfied during the entire lead-based paint removal operation.
      2) Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
      3) Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken. Notify the the Owner immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
      4) For high profile, sensitive work such as present in family housing, child care facilities, administrative buildings, kitchens, barracks, etc., surface dust sampling to determine clearance (i.e., that the work has not contaminated surfaces within and adjacent to the control area) should be performed by a third party to reduce a conflict of interest. Samples must be conducted by an individual not paid or employed or otherwise compensated by the LBP/LCP removal Contractor. State or local regulations may require third party testing if the LBP/LCP removal operation is considered a lead hazard reduction activity.
      5) Before any work begins, collect and analyze baseline or soil wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal.
   b. Air Sampling During Paint Removal Work: Conduct area air sampling daily, on each shift in which lead-based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the the Owner immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after approval is given by the CP and the the Owner. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3. Lead-Based Paint Removal
   a. Manual or power sanding of interior and exterior surfaces is not permitted. Provide methodology for removing LBP in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.
   b. Avoid flash rusting or deterioration of the substrate. Provide surface preparations for painting in accord with Division 7.
   c. Provide methodology for removing LBP/LCP removal processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this LBP/LCP removal process in the LBP/LCPRP.

d. Indoor Lead Paint Removal: Perform manual **OR** mechanical **OR** thermal **OR** chemical, **as directed**, paint removal in lead control areas using enclosures, barriers, or containments and powered locally exhausted paint removal tools. Collect residue and/or debris for disposal in accordance with federal, State, and local requirements.

e. Outdoor Lead Paint Removal: Perform outdoor removal as indicated in federal, State, and local regulations and in the LBP/CPRP. The worksite preparation (barriers or containments) shall be job dependent and presented in the LBP/LCPRP.

f. Sampling After Paint Removal: After the visual inspection, conduct soil sampling if bare soil is present during external removal operations and collect air samples inside and outside the lead control area to determine the airborne levels of lead inside and outside the work area. Collect wipe samples according to the HUD protocol contained in HUD Guidelines to determine the lead content of settled dust and dirt in micrograms per square foot (square meter) of surface area and parts per million (ppm) or micrograms per gram (µg/g) for soil.

4. Cleanup and Disposal

a. Cleanup: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

b. Clearance Certification

1) The CP shall certify in writing that the final air samples collected inside and outside the lead control area are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the the Owner's acknowledgement of receipt of the CP certification.

2) A third party consultant shall certify surface wipe sample results collected inside and outside the work area are less than 100 micrograms per square foot (0.1 square meter) on uncarpeted floors, less than 500 micrograms per square foot (0.1 square meter) on interior window sills and less than 800 micrograms per square foot (0.1 square meter) on window troughs **OR** not significantly greater than the initial surface loading determined prior to work, **as directed**.

3) For exterior paint removal work, soil samples taken at the exterior of the work site shall be sued to determine if soil lead levels had increased at a statistically significant level (significant at the 95 percent confidence limit) from the soil lead levels prior to the work. If soil lead levels do show a statistically significant increase above any applicable Federal or State standard for lead in soil, the soil shall be remediated back to the pre-work level.

c. Testing of Lead-Based Paint Residue and Used Abrasive: Test paint residue and used abrasive in accordance with 40 CFR 261 for hazardous waste.

d. Disposal

1) Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 261. Dispose of lead-contaminated waste material at an EPA or State approved hazardous waste treatment, storage, or disposal facility off Owner’s property.

2) Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon (208 liter) drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The the Owner or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.
3) Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
4) All material, whether hazardous or non-hazardous shall be disposed in accordance with laws and provisions and Federal, State, or local regulations. Ensure waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

5. Disposal Documentation: Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and State or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.
6. Payment for Hazardous Waste: Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Owner.

END OF SECTION 02 83 19 00

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SECTION 02 83 19 00a - XRF TESTING FOR LEAD-BASED PAINT

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for XRF testing for lead-based paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 SUMMARY

A. The Contractor shall perform work in accordance with the latest HUD Guidelines, in accordance with all applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any applicable State or Local standards that may be more stringent than the Federal Standards except, as such guidelines are modified by the Owner in writing in this contract or any contract pursuant to this contract.

B. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.

1.3 SUBMITTALS

A. Notification Before Start of Work
   1. The Contractor shall send notices to the Project Superintendent, Residents, and the Department of Planning and Development 48 hours before the scheduled start of work. The Contractor shall make three (3) attempts to gain entry to each apartment, with proper 48 hour notification to the resident each time.
   2. The Contractor shall begin work no later than 48 hours after receiving a work proceed order.

B. Copies of the submissions listed below must be tendered with the bid:
   1. Ability to perform XRF testing and paint chip sampling by submitting evidence of the successful completion of lead inspector training by all staff to be assigned to the job including inspector technicians. Training must be provided through a State approved EPA-Model program. All staff assigned to the Contract must also demonstrate training in the use of the XRF testing machines to be dedicated to this contract. The serial number of such XRF machine shall be provided to the the Owner.
      a. Contractor or Subcontractor performing the work must have at least 3 years of satisfactory experience (documented) in performing XRF testing for a City, State or Federal Agency.
   2. Laboratory certification by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
   3. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated above must also be provided for the subcontractor.

C. XRF Testing Report Format

a. All XRF report must be made after a formal submittal and approval by the Owner.
b. A faxed summary report must be provided to the the Owner within 48 hours after completion of testing for a work Authorization. For XRF testing requiring confirmation by laboratory analysis of paint chip samples, the faxed summary report must be provided within 48 hours after the the Owner gives approval for testing of the collected paint chip samples.
c. A detailed report must be provided to the the Owner within 5 business days after completion of the testing.

1.4 QUALITY ASSURANCE

A. The work shall consist of furnishing all labor, material, insurance and all other incidental items required to do the following:
1. XRF Testing
a. Random or comprehensive testing of various components in single family housing units, multi-family housing units, common areas and exterior sites, using any of the approved X-ray Fluorescence ("XRF") machines, to determine if the lead-based paint concentration is within permissible limits.
Note: Testing may be for entire apartments or selected rooms or components within the apartment.
b. The permissible limit shall be defined as a final reading showing a lead concentration of less than 1.0 mg/cm².
c. Refer to the Manufacturer's manual, as well as the "XRF Performance Characteristic Sheet" when determining calibration check tolerance, and other instrument specific information. Use the adjusted "XRF Performance Characteristic Sheets" in this contract when determining the inconclusive range.
d. In addition to the manufacturer's recommended warm up and quality control procedures, a set of three nominal XRF calibration check readings must be taken before the inspection begins and after the inspection has been completed in a particular unit, or every 4 hours, whichever occurs first. All reference material values and calibration check readings must be included in the report provided to the Owner.
e. Do not use the XRF to test highly curved or ornate surfaces, or surfaces inaccessible to the XRF, due to poor reliability of results. For such surfaces, laboratory analysis of paint chips must be done.
f. Only one XRF reading is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
g. All inconclusive results must be treated according to the inspection rules using multi-family inspection or single family inspection rules as appropriate.
h. XRF field data sheets shall be filled out as they appear on completed Form 7.1(“Single-Family Housing LBP Testing Data Sheet”) and 7.5 (“"Multifamily Housing LBP Testing Data Sheet”) in HUD Guidelines.
i. Room equivalents or sections thereof that are not accessible for testing (i.e. locked bedrooms) shall be noted in the final report to the Owner.
2. Laboratory testing of paint chips.
a. Collection of paint chips from various painted components for laboratory analysis due to XRF substrate corrected inconclusive and/or positive readings as directed by the the Owner.

b. Laboratory preparation and testing by Flame Atomic Absorption Spectrometry (FAAS) or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) to determine if the lead paint concentration is within permissible limits.
c. The permissible limit shall be defined as a lead concentration less than 0.5% by weight.
d. Collect paint chips in accordance with ASTM ES28-94.
e. Prepare paint chips in the laboratory for testing in accordance with ASTM ES37-94.
f. Repair and repaint areas from which paint chips have been collected, to match adjacent areas, unless notified by the the Owner in writing to utilize a temporary covering for the tested surfaces. The Contractor shall provide water based latex paint for this purpose. Colors shall be limited to white and off-white; and other colors if provided by the tenant.
g. Only one paint chip is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate, and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
h. Field data sheets and signed chain of custodies must be attached to the final report to the Owner.

B. Occupied Residences
1. Some of the work of this contract will be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
2. The Contractor shall take all necessary precautions to protect the property of the the Owner, its residents and the public. The contractor must repair any damaged property, whether of the the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgement of the the Owner, match the existing materials and are of equal quality and workmanship. All such repairs shall be at the Contractor's expense.

C. Applicable Regulations
1. ASTME Standards
a. ASTM E 1583 on evaluating laboratories used to determine lead levels;
b. ASTM E 1605 on terminology;
c. ASTM E 1613 on determining lead by atomic emission or atomic absorption spectroscopy;
d. ASTM E 1645 on laboratory preparation of paint-chip samples;
e. ASTM E 1775 on-site extraction and field portable stripping voltammetry analysis for lead;
f. ASTM PS 53 on identifying and managing lead in facilities;
g. ASTM PS 87 on ultrasonic extraction for later analysis for lead;
h. ASTM PS 88 on determining lead by portable electro analysis
2. OSHA Standards (without limitation), include:
a. 29 CFR 1926.20 - General safety and health provisions;
b. 29 CFR 1926.21 - Safety training and education;
c. 29 CFR 1925.25 - Housekeeping;
d. 29 CFR 1926.28 - Personal protective equipment;
e. 29 CFR 1926.51(f) - Washing facilities;
f. 29 CFR 1926.55 - Gases, vapors, fumes, dusts, and mists;
g. 29 CFR 1926.57 - Ventilations;
h. 29 CFR 1926.59 - Hazardous Communication Standards;
i. 29 CFR 1926.10 - Respiratory protection; and
j. 29 CFR 1926.62 - Lead in Construction
3. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).

4. The Contractor must follow the XRF Performance Characteristic Sheet (PCS) for all inspection activities. XRF PCSs are available from the National Lead Information Center Clearinghouse or through the HUD website at http://www.hud.gov/offices/lead/lbp/hudguidelines/allpcs.pdf.

1.5 PRODUCTS

A. XRF Instruments and Testing Protocols
1. The Contractor shall use XRF instruments that are approved by the Owner.
2. XRFs must be used in accordance with the manufacturer's instructions and the XRF Performance Characteristic Sheet. If discrepancies exist between the XRF Performance Characteristic Sheet, the HUD Guidelines and the manufacturer's instructions, the most stringent guidelines should be followed.

1.6 EXECUTION

A. Inspection and Testing
1. Single Family Testing Rules
a. If the housing development has less
1) than 10 units built between 1960-1970 or
2) 20 units built before 1960 or
3) the random testing rules in a multi-family development are not being used then single family testing rules must be followed.
b. List all testing combinations (see HUD Guidelines Table for an example) in all interior rooms, on all exterior building surfaces, and on surfaces in other exterior areas, such as fences, playground equipment, and garages. The “SingleFamily Housing LBP Testing Data Sheet” (see HUD Guidelines) or a comparable data collection instrument may be used for this purpose.
1) Test all room equivalents inside and outside the dwelling unit. The final report must include a final determination of the presence or absence of lead-based paint on each testing combination in each room equivalent.
2) Inspect each testing combination in each room equivalent, unless similar building component types with identical substrates (such as windows) are all found to contain lead-based paint in the first five interior room equivalents. In that case, testing of that component type in the remaining room equivalents may be discontinued, if and only if the Owner agrees beforehand to such a discontinuation. The inspector should then conclude that similar building component types in the rest of the dwelling unit also contain lead-based paint.
3) Painted furniture that is physically attached to the unit (for example, a desk or dresser that is built-in) should be included in the inspection as a testing combination.
4) Results of an inspection may be summarized by classifying component types across room equivalents if patterns or trends are supported by the data.
5) All substrates across all room equivalents should be grouped into one of the six substrate categories (brick, concrete, drywall, metal, plaster, or wood).
c. Number and Location of XRF Readings
1) XRF testing is required for at least one location per layers of paint should be included and the XRF probe testing combination, except for interior and exterior faceplate should be able to lie flat against the surface walls, where four readings should be taken, one on of the test location each wall.
2) For interior and exterior walls: take at least four readings (one of ea. wall). If there are more than four walls test the four largest walls, calculate the average of the

readings, round the result to same number of decimal places as the XRF instrument displays, and classify the remaining walls with the same painting history as the tested walls, based on this rounded average. When the remaining walls in a room equivalent clearly do not have the same painting history as that of the tested walls, test and classify the remaining walls individually.

3) Select areas of paint which are most likely to have old paint or coatings, where areas of paint appear thickest. Avoid testing where paint has worn away, chipped; or over pipes, electrical surfaces, nails, and any other possible interferences.

4) A numbering system, floor plan, sketch or other system may be used to document which testing combinations were tested and sufficiently detailed enough for another individual to find them.

a) Side identification Identify perimeter wall sides with letters A, B, C, and D (or numbers or Roman numerals). Side A for single-family housing is the street side for the address. Side A in multi-family housing is the apartment entry door side. Side B, C, and D are identified clockwise from Side A as one faces the dwelling; thus Wall B is to the left, Wall C is across from Side A, and Side D is to the right of Side A. Each room equivalent's side identification follows the scheme for the whole housing unit. Because a room can have two or more entries, sides should not be allocated based on the entry point. For example, giving a closet a side allocation based on how the room is entered would make it difficult for another person to make an easy identification, especially if the room had two closets and two entryways.

b) Room Equivalent Identification Room equivalents should be identified by both a number and a use pattern (for example, Room 5-Kitchen). Room 1 can always be the first room, at the A-D junction at the entryway, or it can be the exterior. Rooms are consecutively numbered clockwise. If multiple closets exist, they are given the side allocation: for example, Room 3, Side C Closet. The exterior is always assigned a separate room equivalent identifier.

c) Sides in a Room Sides in an interior room equivalent follow the overall housing unit side allocation. Therefore, when standing in any four-sided room facing Side C, the room's Side A will always be to the rear, Side B will be to the left, and Side D will be to the right.

d) Building Component Identification Individual building components are first identified by their room number and side allocation (for example, the radiator in Room 1, Side B is easily identified). If multiple similar component types are in a room (for example, three windows), they are differentiated from each other by side allocation. If multiple components are on the same wall side, they are differentiated by being numbered left to right when facing the components. For example, three windows on Wall D are identified as windows D1, D2, and D3, left to right. If window D3 has the only old original sash, it is considered a separate testing combination from the other two windows. Codes or abbreviations for building components and/or locations may be used in order to shorten the time needed for data entry. If codes or abbreviations are used, the inspection records and the inspection report must include a table showing their meaning.

d. XRF Instrument Reading Time

1) The recommended time to open an XRF instrument's shutter to obtain a single XRF result for a testing location depends on the specific XRF instrument model and the mode in which the instrument is operating. Follow manufacturer's instructions per HUD Guidelines.

e. XRF Calibration Check Readings

1) Follow manufacturer's instructions per HUD Guidelines.

f. Substrate Correction

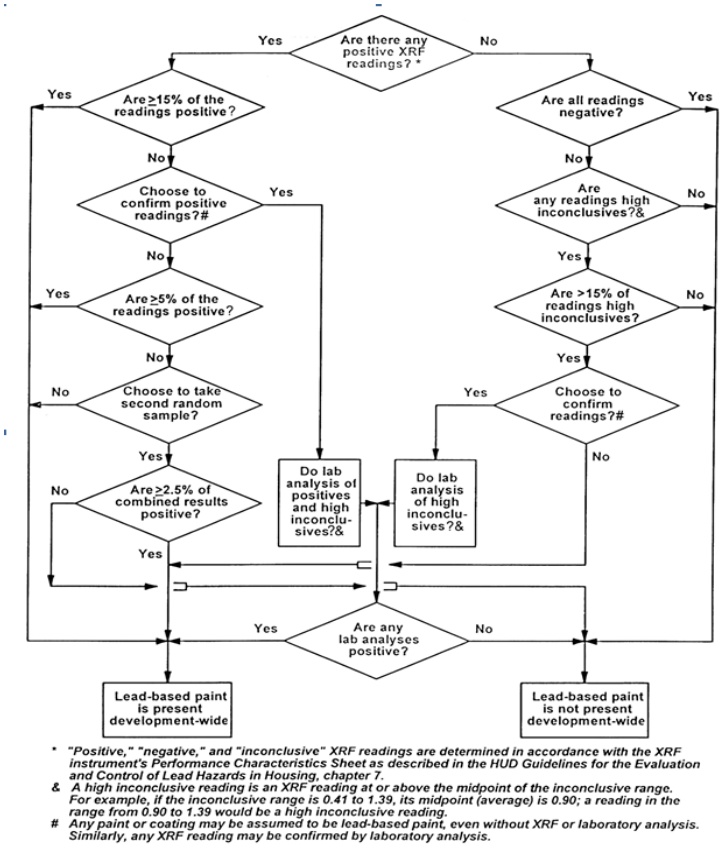
1) The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:

a) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.

b) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.

c) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.

g. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



1)

2) All inconclusive results must be confirmed with laboratory analysis, or as an alternative must be classified as positive. the Owner may also wish to confirm positive XRF results with laboratory analysis. Therefore the Contractor must make a field determination of which XRF readings falls in the inconclusive or positive ranges and take paint chip samples during the XRF testing for possible laboratory analysis. If the majority of XRF readings are positive in the first few units, the inspector must consult with the Owner on whether to continue taking paint chip samples. Only the Owner may determine whether to submit collected paint chip samples for laboratory analysis or to classify the element as positive.

2. Multi-family Housing Testing Rules (Random Sampling)

a. In order to use the Multi-family housing testing rules, there must multi-family housing is defined as any group of more than four units that are similar in construction from unit to unit

b. Determine the number of randomly selected units to be tested in accordance with Table 7.3, below. Chapter 7 of the HUD Guidelines also describes how to select the units randomly. If a unit or units which were selected as part of the original random sample cannot be entered for a particular reason, a replacement unit(s) must be randomly selected in accordance with the HUD Guidelines.

Table 7.3 Number of Units to be Tested in Multi-family Building or Developments*

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
1-10	All	All
11-13	All	10
14	All	11
15	All	12
16-17	All	13
18	All	14
19	All	15
20	All	16
21-26	20	16
27	21	17
28	22	18
29	23	18
30	23	19
31	24	19
32	25	19
33-34	26	19
35	27	19
36	28	19
37	29	19
38-39	30	20
40-48	31	21
49-50	31	22
51	32	22
52-53	33	22
54	34	22
55-56	35	22
57-58	36	22
59	37	23
60-69	38	23
70-73	38	24
74-75	39	24
76-77	40	24

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
78-79	41	24
80-88	42	24
89-95	42	25
96-97	43	25
98-99	44	25
100-109	45	25
110-117	45	26
118-119	46	26
120-138	47	26
139-157	48	26
158-159	49	26
160-177	49	27
178-197	50	27
198-218	51	27
219-258	52	27
259-279	53	27
280-299	53	28
300-379	54	28
380-499	55	28
500-776	56	28
777-939	57	28
940-1004	57	29
1005-1022	58	29
1023-1032	59	29
1033-1039	59	30
1500	87	44
2000	116	58
2500	145	73
3000	174	87
3500	203	102
4000	232	116

* For brevity, "Number of Units" and "Number of Units to Test" are used, but the number to test is the same for similar units, similar common areas, and similar exterior sites.

c. An assessment on each tested component must note four attributes, also called a testing combination.
   1) The room equivalent (where the testing took place i.e. bedroom, bathroom, etc.)
   2) The component type (door, wall #1 - upper left, etc.)
   3) The substrate (brick, wood, concrete, drywall, plaster or metal).
   4) The color of the paint.

d. These attributes must be included as part of the report.

e. For each testing combination, the condition of the painted surfaces should be noted as either intact, fair or poor.

f. One reading with the X-ray fluorescence (XRF) instrument on each testing combination is all that is required.

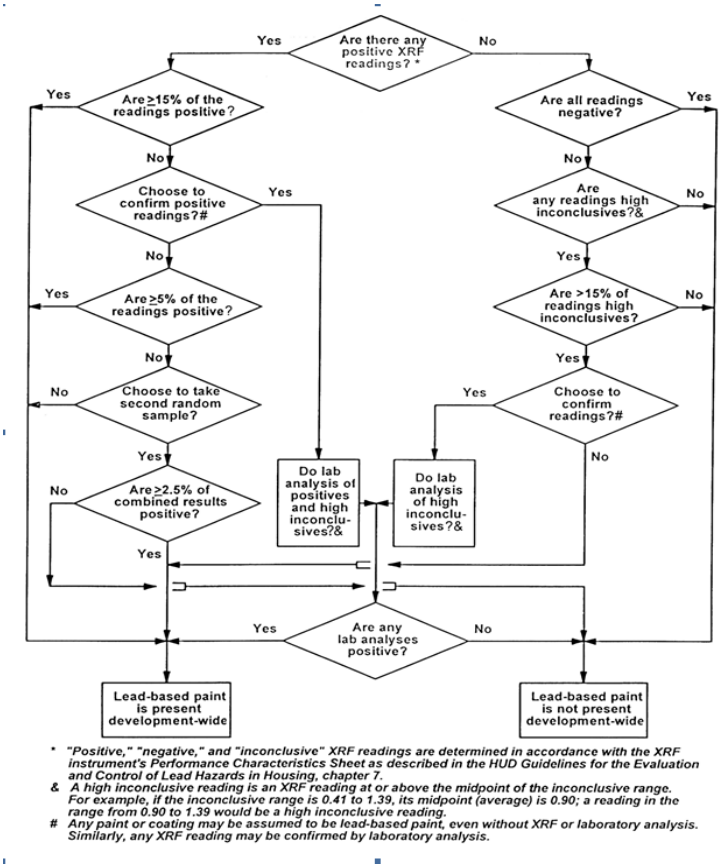
g. At least 40 components of a given type must be tested to obtain the desired level of confidence in the results throughout the multi-family development. If less than 40 components of a given type exist in the buildings to be tested i.e. they are unique components, then the measurement should be taken using single family testing rules (described below). If less than 40 components of a given type exist in the units to be tested, additional components of this type can be identified in other units in the complex and tested to bring the total up to 40 so that multi-family testing rules can be used. The decision of which option the Contractor should use will be made by the the Owner.

h. To increase the number of tested components of a given type, testing combinations with different colors on the same component and substrate may be combined into a single component type. For example, if "wood doors" is the component type, all wood doors tested for lead-based paint could belong to the same component type, regardless of color.

i. A component type may be differentiated by color as long as there are 40 tested and there is a good reason for differentiation.

j. The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:
   1) Positive- A positive XRF reading in accordance with the XRF’s Performance Characteristic Sheet.
   2) Negative- A negative XRF reading in accordance with the XRF’s Performance Characteristic Sheet.
   3) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF’s inconclusive range, in accordance with the XRF’s Performance Characteristic Sheet.

k. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



l. If there are readings on a component type(s) equal to or greater than 1.0 mg/cm² and paint chip samples are submitted to the laboratory, there are two possible results:

1) If all lab samples on a component type are below 0.5% lead by weight, the component type can be classified as negative throughout the development.
2) If one or more lab results are positive, (equal to or greater than 0.5% lead by weight for a component) the the Owner will take one of three options:
   a) Treat the component type as positive throughout the development, or
   b) Test the component type throughout the development, or
   c) If 5% or less of the component type are positive, take a second random sample, just testing that component type.
3) If option 2)c) above is selected by the Owner and the combined results of the first and second random sample are less than 2½% positive, the following additional options are available depending on the results.
   a) If no positives are found in the second sample, no further testing is necessary. Those positives in the first random sample will be monitored/abated (not by this Agreement), but the rest of the component type can be classified as negative.

b) If positives are found on a component type in the second sample, the the Owner has the option to classify the component type as positive throughout the development or comprehensively test it.

c) If the combined results of the two random samples are equal to or greater than 2½%, the the Owner also has the option to comprehensively test the remaining components of that type or classify them as positive.

m. Paint Chip Sample Size: The Paint chip samples should be taken from a 4 square inch (25 square centimeter) area that is representative of the paint on the testing combination, as close as possible to any XRF reading locations and, if possible, unobtrusive. This area may be a 2" x 2" (5 x 5 centimeters) square, or a 1" x 4" (2.5 x 10 centimeters) rectangle, or have any other dimensions that equal at least 4 square inches (25 square centimeters). Regardless of shape, the dimensions of the surface area must be accurately measured (to the nearest millimeter or $1/16^{th}$ of an inch) so that the laboratory results can be reported in $mg/cm^{2.}$ Results should be reported as percent by weight if the surface area cannot be measured accurately or if all paint within the sampled area cannot be removed. In these cases, lead should be reported in ppm or percent weight, not in mg/cm^2. Smaller surface area can be used if acceptable to the laboratory. (See ASTME 1729). In all cases those who take the samples should consult with the NLLAP recognized laboratory selected regarding the requirements for the submission samples for lead-based paint analysis.

n. If the the Owner decides to test in search of these hard-to-find components coated with lead based paint, the inspector must use the single family testing rules described in the previous section.

3. Common Areas and Exterior Sites Testing Rules

a. Similar common areas and similar exterior sites must always be tested, but in some cases they can be sampled in much the same way that dwelling units are. Common areas and building exteriors typically have a similar painting history from one building to the next. In multifamily housing, each common area (such as building lobby, laundry room, or hallway) can be treated as a dwelling unit. If there are multiple similar common areas, they may be grouped for sampling purposes I exactly the same way as regular dwelling units. However, dwelling units, common areas and exterior sites cannot be all mixed together in a single group. All testing combinations within each common area or building exteriors selected for testing must be inspected. This includes playground equipment, benches and miscellaneous testing combinations located throughout the development. The specific common areas and building exteriors to test should be randomly selected, in much the same way as specific units are selected using random numbers. The number of common areas to be tested should be taken from table 7.3 (HUD Guidelines). In this instance, common areas and building exteriors can be treated in the same way as housing units (although they are not to be confused with true housing units).

4. Unit and Common Area Drawings

a. Mark-ups of as built drawings depicting room equivalents that are tested must be provided as part of the report.

b. The Contractor should test in a clockwise path starting from the door through the space and room equivalents so that the approximate location of each component tested can be easily established by referencing the room equivalent and sides.

c. Each space must have a reference point (side A, B, C, D or wall 1, 2, 3 or 4). The wall with the door should always be referenced as wall 1 or side A. If there is more than one door, wall 1 or side A should be used to refer to the wall with the door through which the room is first entered when moving in a clockwise fashion through the unit.

B. Evaluation of the Inspection by the the Owner

1. The Contractor will be required to carry out retesting at no additional cost to the the Owner, after completion of the Inspection at each the Owner's development as described in the HUD Guidelines, for single family housing, multi-family housing and common areas. The the Owner shall randomly select the testing combinations to be retested and the Contractor shall perform the retesting using the same XRF instrument(s) which was/were used to take the original readings. An the Owner's inspector shall be present to observe all retesting. The retesting shall be limited to ten (10) testing combinations, and if necessary to repeat the retest, the testing combinations randomly selected for repeating the retest shall also be limited to ten.
2. If the retest tolerance limit computed from the information provided in the "XRF Performance Characteristics Sheet" (see HUD Guidelines) is exceeded, the retest will be repeated as described in the HUD Guidelines for single family, multi-family housing and common areas. If the retest tolerance limit is exceeded again, the the Owner may require the Contractor to retest the entire development at no additional cost to the the Owner, or the the Owner may withhold all payments and terminate its agreement with the Contractor.

C. Option to do Laboratory Testing only
1. The the Owner may, for a specific testing assignment, request in writing that the Contractor, when utilizing the multi-family housing testing rules for random sampling, or the single family housing testing rules, do all testing through laboratory analysis of paint chips rather than through XRF Spectrum Analyzer testing with laboratory confirmation as needed. Please note that under the single family housing testing rules, only one paint chip must be taken and analyzed for each component type.

D. Waste Disposal
1. All waste generated must be legally disposed in accordance with Federal, State and Local regulations.

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SECTION 02 83 19 00b - LEAD DUST WIPE, AIR AND TCLP SAMPLING AND ANALYSIS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for lead dust wipe, air and TCLP sampling and analysis. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions: Unless otherwise specified the following definitions shall apply:

1. **"Approved"**: shall mean approved by all public agencies having jurisdiction, and the Owner.
2. **"The Owner"**: shall mean the Owner and its designated authorized representatives.
3. **"Contractor"**: shall mean the firm that is awarded this contract and is responsible to ensure compliance with Federal, State and City regulations as well as these Contract documents.
4. **"Development or Project"**: a group of buildings in one or more designated geographical locations, owned or operated by the Owner and referred to by a common name by the Owner.
5. **"Dust Cleaning Firm"**: shall mean the contractor under a separate contract or the Owner responsible for cleaning of lead dust, as directed by the Owner, until the clearance levels are achieved, as defined in the "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995" or latest edition published by the United States Department of Housing and Urban Development (HUD).
6. **"Equal or Approved Equal"**: shall mean equal in the opinion of the Owner.
7. **"HUD"**: the United States Department of Housing and Urban Development.
8. **"HUD Guidelines"**: shall mean Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing issued by HUD'S Office of Lead-Based Paint Abatement and Poisoning Prevention in June 1995 except as such guidelines are later modified by HUD and/or modified by the Owner in writing pursuant to this contract.
9. **"Inspector"**: an individual who has completed training from an accredited program and been licensed or certified by the appropriate State or local agency to (1) perform inspections to determine and report the presence of lead-based paint on a surface-by-surface basis through on-site testing, (2) report the findings of such an inspection, (3) collect environmental samples for laboratory analysis, (4) perform clearance testing, and (5) document successful compliance with lead-based paint hazard control requirements or standards.
10. **"Lead-Based Paint"**: any paint, varnish, shellac, or other coating that contains lead equal to or greater than 1.0 mg/cm² as measured by XRF or laboratory analysis, or 0.5 percent by weight (5,000 µg/g, 5,000 PPM, or 5,000 mg/kg) as measured by laboratory analysis.
11. **"Lead-Based Paint Hazard"**: a condition in which exposure to lead from lead-contaminated dust, lead-contaminated soil or deteriorated lead-based paint would have an adverse effect on human health (as established by the EPA Administrator under Title IV of the Toxic Substance Control Act). Lead-based paint hazards include for example, deteriorated lead-based paint, leaded dust levels above applicable standards and bare leaded soil above applicable standards.
12. **"Lead-Based Paint Hazard Control"**: activities to control or eliminate lead-based paint hazards, including interim controls and complete abatement.
13. **"Lead-Contaminated Dust"**: surface dust in residences that contain an area or mass concentration of lead in excess of the standard established by the EPA Administrator, pursuant to Title IV of the Toxic Substance Control Act. Until the EPA standards are set, the HUD recommended clearance and risk assessment standards for leaded dust are 40 µg/ft² on floors, 250 µg/ft² on interior window sills, and 800 µg/ft² on window troughs.
14. **"Monitoring"**: shall refer to inspection to ensure compliance with all Federal, State and City Standards or guidelines, and contractual specifications.
15. **"Provide"**: shall mean furnish and install.

16. **"Risk Assessor"**: a certified individual who has completed training with an accredited training program and who has been certified to (1) perform risk assessments, (2) identify acceptable abatement and interim control strategies for reducing identified lead-based paint hazards, (3) perform clearance testing and reevaluations, and (4) document the successful completion of lead-based paint hazard control activities.

Applicable Regulations/References

17. The work conducted shall comply with all applicable Federal, State and City regulations. Applicable guidelines and standards listed in the scope of work include, but are not limited to:

24 CFR Parts 35,36,37	HUD Lead-Based Paint Regulations
Guidelines for the Evaluation and Control of Lead-Based Paint in Housing (HUD Guidelines June 1995) & 1997 Revisions	
29 CFR 1910	General Industry Standard
29 CFR 1910.1025	Lead Standard for General Industry
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1200	Hazard Communication
29 CFR 1910.245	Specification for Accident Prevention
29 CFR 1926	Construction Industry Standards
29 CFR 1926.20	General Safety & Health Provisions
29 CFR 1926.21	Safety Training & Education
29 CFR 1926.25	Housekeeping
29 CFR 1926.28	Personal Protective Equipment
29 CFR 1926.51	Washing Facilities
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts & Mists
29 CFR 1926.59	Hazard Communication Standard
29 CFR 1926.62	Construction Industry Lead Standard
29 CFR 1926.103	Respiratory Protection
40 CFR 61 Subpart A	General Provisions
40 CFR 241	Guidelines for the Land Disposal of Solid Waste
40 CFR 257	Criteria for the Land Disposal of Solid Waste
40 CFR 261/262	Waste Disposal Facilities & Practices
American National Standards Institute (ANSI) Z87.1	Eye Protection
ANSI Z88.2-80	Practices for Respiratory Protection
American Society For Testing Materials (ASTM)	All Applicable Standards

18. The contractor shall ensure that any programs, certifications, licenses or other documentation in accordance with the above and/or any other applicable Federal, State, and Local Regulations/Guidelines are provided.

Scope Of Work

19. The work shall consist of furnishing labor, materials, insurance and all other incidental items required to perform the following:
    a. Dust wipe sampling and analysis
        1) Collect dust wipe samples from various horizontal surfaces, such as floors, window sills, window troughs, etc., as directed by the Owner.
        2) Dust wipe samples shall be collected in accordance with ASTM ES30-94.
        3) Analyze dust wipe sample in the laboratory using Flame Atomic Absorption Spectrometry ("FAAS") or Graphite Furnace Atomic Absorption Spectrometry("GFAAS").
        4) Provide result of analysis in micrograms per square foot.

5) A faxed summary of results must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected dust wipe sample. Contractor shall also have the ability to provide results in 4 hours for clearance, following lead-based paint abatement work, if requested by the Owner. The sampling result must be provided in a form approved by the Owner and must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and an indication of pass or fail.
6) Turn-around time for results shall be counted from the time the Contractor performs collection of dust wipe samples to the time the results are actually presented to the Owner. This includes travel time from the site to the laboratory of the Contractor and back to the site.
7) A detailed final report covering the results of all dust wipe samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and indicate pass or fail in a form approved by the Owner. Also include in the report the method of analysis, i.e. "FAAS" or "GFAAS", and the detection limits. The laboratory test results in the final report must be signed by the Laboratory Director.
8) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
9) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.

b. Dust Spiked Samples
1) Provide dust spiked samples to the Owner. Dust spiked samples shall be prepared in accordance with the HUD Guidelines.

NOTE: These samples are separate from the ones required by the Contractor for its own QA/QC

2) Prepare dust spiked samples in a manner such that they are indistinguishable from the field samples.
3) Prepare dust spiked samples using the same lot as that to be used in the field.
4) Dust spiked samples shall be inserted into the sample stream, randomly, by the Owner Inspector.
5) Blind analysis of dust spiked samples must fall within 80%-120% of the true value. If the laboratory fails to obtain readings within these limits, two more spiked samples shall be sent immediately to the lab for analysis.
6) If the two additional spiked samples fail, the sample batch shall be considered invalid, and the Owner may, at its sole discretion, terminate this contract as well as withhold payment for services already rendered.

c. Air Sampling and Analysis
1) Collect area air samples at various locations and various projects for personal exposure assessment as directed by the Owner.
2) Air samples shall be collected in accordance with ASTM E1553-93.
3) Prepare air samples for analysis in accordance with ASTM E33-94
4) Analyze air samples using FAAS or GFAAS.

5) All equipment required for personal air sampling, including pumps shall be provided by the Contractor at no extra cost to the Owner.
6) Provide results of air samples in micrograms per cubic meter.
7) A faxed summary of result must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected air sample. The sampling result must include for each air sample taken the Project, the building address, the sample number, the room or room equivalent, and the reading.
8) Turn-around time shall start after collection of the air samples, and includes travel time to and from the laboratory.
9) A detailed final report covering the results of all air samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each air sample, the Project, the building address, the sample number, the room or room equivalent, and the reading. The laboratory report contained in the final report must be signed by the Laboratory Director.
10) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
11) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"),or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
12) Air sampling technician shall be present during the entire shift of the air sampling.

d. TCLP Sampling and Analysis
1) Take core samples of construction waste as directed by the Owner and analyze by TCLP testing to determine if waste is hazardous.
2) Waste shall be classified as hazardous if the concentration of lead is greater than 5 parts per million by TCLP testing.
3) The laboratory used for the analysis of the TCLP samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
4) A faxed summary of result must be provided to the Owner within 48 hours after the Owner authorizes the Contractor to perform the TCLP analysis of the waste. Provide results in parts per million (ppm).
5) Final results provided to the Owner by the Contractor must include written sample preparation procedure and laboratory specific written procedures for performing TCLP, including quality control procedures used for performing the TCLP, and a table listing the sample numbers, description of the construction waste, and the result of the TCLP. The laboratory report contained in the final report must be signed by the Laboratory Director.
6) Final report must also specify detection limits.
7) Final report must be provided within 5 days from the time the authorization to perform the TCLP is given by the Owner.

General Provisions

20. Some of the work of this contract may be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
21. The Contractor shall take all necessary precautions to protect the property of the Owner, its residents, and the public. The Contractor must repair any damaged property, whether of the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgment of the Owner, match the existing materials and/or of equal quality and workmanship. All such repairs shall be at the Contractor's expense.
22. The Contractor shall develop a work plan to be performed as requested by the Department of Planning and Development. The detailed plan shall include coordination of the monitoring and sampling work with the Contractor in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
23. The Contractor shall perform work in accordance with the latest HUD Guidelines, except as such Guidelines are modified by the Owner in writing in this Contract, or any Contract pursuant to this Contract, and in accordance with all applicable Federal, State and Local regulations.
24. The Contractor shall include in the bid price all supplementary miscellaneous items not specified but implied or required in order to complete the work.

Submissions

25. Six (6) copies of the submissions listed below must be submitted to the Owner by the Contractor or Subcontractor performing the Work:
    a. Ability to perform lead dust wipe sampling by submitting evidence of the successful completion of lead inspector and/or risk assessor training by all staff to be assigned to the job including inspector technicians. As stated previously, training must be provided through an approved program.
    b. Laboratory certification by the State Department of Health (or other responsible agency) through its ELAP program and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided.
    c. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated in (2) above must also be provided for the subcontractor.

Waste Disposal

26. All waste generated must be legally disposed in accordance with the Federal, State and Local Regulations.

END OF SECTION 02 83 19 00b

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Task	Specification	Specification Description
02 83 19 00	02 83 00 00	Lead Remediation
02 83 19 13	02 83 00 00	Lead Remediation
02 83 19 13	02 83 19 00	Lead-Based Paint Remediation
02 83 19 13	02 83 19 00a	XRF Testing For Lead-Based Paint
02 83 19 13	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 83 33 00	02 83 00 00	Lead Remediation
02 83 33 13	02 83 00 00	Lead Remediation
02 83 33 13	02 83 19 00	Lead-Based Paint Remediation
02 83 33 13	02 83 19 00a	XRF Testing For Lead-Based Paint
02 83 33 13	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis

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SECTION 02 84 16 00 - HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBS AND MERCURY

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for removal of fluorescent light ballasts/capacitors and fluorescent light tubes. Products shall be as follows or as directed by the the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Before Start of Work: Submit the following to the Owner's Representative for review. Do not start work until these submittals are returned with Owner's Representative's approval.
   a. Copy of State or local license for hazardous waste hauler;
   b. Certification of at least one on-site supervisor which has satisfactorily completed the OSHA 40 Hour Health and Safety Course for Handling Hazardous Materials;
   c. Certificates of workers which have successfully completed at least the OSHA 40-Hour Health and Safety Course for Hazardous Materials;
   d. List of employees scheduled to perform this work;
   e. Schedule of start and finish times and dates for this work;
   f. Name and address of landfill where these waste materials are to be deposited (include contact person and telephone numbers);
   g. Safety Data Sheets for all materials requiring removal;
   h. If contractor introduces any chemical into the work environmental, a SDS for that chemical is required before use;
   i. Transporter must have notified the EPA and/or the appropriate local government agency in advance of its intentions to transport PCB's, mercury and cadmium, and receive an identification number pursuant to the Toxic Substance Control Act (TSCA); and
   j. Contingency Plan for handling emergency spills or leaks.

1.2 PRODUCTS

A. Materials
1. Polyethylene Sheet: A single polyethylene film in the largest sheet size possible to minimize seams, 4.0 and 6.0 mil thick, clear, frosted, or black.
2. Duct Tape: Provide duct tape in 3" widths, witty an adhesive which is formulated to stick aggressively to sheet polyethylene.
3. Spray Cement: Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene.
4. Disposal Bays: Provide 6 mil thick leak-tight polyethylene bags.
5. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
6. **Drums:** Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA EPA (40 CFR Parts 264265 and 300), and DOT regulations (49 CFR Parts 171-178). Use of damaged drums will not be allowed.

1.3 EXECUTION

A. General
1. Where necessary, scaffolding shall be erected to fully access all applicable fluorescent light ballasts/capacitors and tubes. At no time will the ballasts/capacitors and tubes be allowed to drop onto the floor. Contractor must take care to protect from dropping the ballasts/capacitors and fluorescent tubes.
2. Prior to removing ballasts/capacitors and fluorescent tubes, contractor shall ensure that all electrical service to lights has been shut off, and locked out. Temporary lighting shall be erected to adequately illuminate work areas.
3. Depending on height of light fixtures, contractor shall utilize at least a 2-person per team system. The fluorescent light tubes shall be removed and passed to the appropriate number of workers required to lower the tubes to the floor without breaking them.
4. The worker on the floor shall lay the tubes in cardboard boxes large enough to hold a small quantity of tubes. Worker shall take care to not damage the tubes while they are lowered into the box. Once the box is full, it shall be wrapped with two layers of 6 mil thick polyethylene sheeting and sealed with duct tape.
5. Contractor may choose to either remove the fluorescent light ballasts/capacitors in-place or lower the lighting fixtures for easy access. The ballasts/capacitors shall be removed from the fixtures. Electrical wiring leading from the ballasts/capacitors shall be cut away. Ballasts/capacitors shall be placed in 55-gallon drums lined with at least two 6 mil thick polyethylene bags. Be careful not to overfill the drums so that they remain manageable. Once the drums have been filled to the acceptable level, seal the lid onto the top of the drum, and affix appropriate labels. Transport drums via hand dollies.

B. Worker Protection
1. As a minimum, while working with the ballasts/capacitors and light tubes, workers shall utilize impervious gloves adequate for the use with hazardous materials. If light ballasts/capacitors and/or light tubes are damaged, and/or exposure to these materials may reach the OSHA PEL or AGGIH threshold limit value (TLV), the contractor shall be required to provide impervious full body protection and respiratory protection. However, contractor is required to verify the type of protection required prior to working with these materials, and have written approval by Owner's Representative prior to beginning.
2. In addition, workers shall not smoke, drink or eat in these areas during work activities.

C. Storage Of Fluorescent Light Ballasts/Capacitors And Light Tubes
1. Once the containers holding the ballasts/capacitors and light tubes have been filled and sealed, they shall be stored in designated areas as agreed upon by the Owners Representative and Contractor. They shall not be allowed to be stored on-site in transportation vehicles until the time for them to be transported to the hazardous waste incinerators or landfill facility.

END OF SECTION 02 84 16 00

SECTION 02 87 13 00 - MOLD REMEDIATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the removal and disposal of mold. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. List of all personnel to be involved in the work with their training and certifications.
2. List of all products and procedures proposed for use in performance of the work.
3. Test reports.
4. Certificates.

C. References
1. U.S. EPA “Mold Remediation in Schools and Commercial Buildings”
2. U.S. EPA “A Brief Guide to Mold, Moisture, and Your Home”

D. Quality Assurance
1. Conform to all Federal, State, and Local regulations which govern the handling and disposal of mold materials.

1.2 PRODUCT - (Not Used)

1.3 EXECUTION

A. Environmental Assessment: The presence of mold, water damage, or musty odors shall be addressed immediately. In all instances, any source(s) of water must be stopped and the extent of water damaged determined. Water damaged materials shall be dried and repaired. Mold damaged materials shall be remediated in accordance with this document.
1. Visual Inspection: A visual inspection is the most important initial step in identifying a possible contamination problem. The extent of any water damage and mold growth shall be visually assessed. This assessment is important in determining remedial strategies. Ventilation systems shall also be visually checked, particularly for damp filters but also for damp conditions elsewhere in the system and overall cleanliness. Ceiling tiles, gypsum wallboard (sheetrock), cardboard, paper, and other cellulosic surfaces shall be given careful attention during a visual inspection. The use of equipment such as a boroscope, to view spaces in ductwork or behind walls, or a moisture meter, to detect moisture in building materials, may be helpful in identifying hidden sources of fungal growth and the extent of water damage.
2. Bulk/Surface Sampling
a. Bulk or surface sampling is not required to undertake a remediation. Remediation of visually identified fungal contamination shall proceed without further evaluation.
b. Bulk or surface samples may need to be collected to identify specific fungal contaminants as part of a medical evaluation if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is equivocal (e.g., discoloration, and staining).
c. An individual trained in appropriate sampling methodology shall perform bulk or surface sampling. Bulk samples shall be collected from visibly moldy surfaces by scraping or cutting materials with a clean tool into a clean plastic bag. Surface samples shall be collected by wiping a measured area with a sterile swab or by stripping the suspect surface

with clear tape. Surface sampling is less destructive than bulk sampling. Other sampling methods may also be available. A laboratory specializing in mycology shall be consulted for specific sampling and delivery instructions.

3. Air Monitoring
   a. Air sampling for fungi shall not be part of a routine assessment. This is because decisions about appropriate remediation strategies can usually be made on the basis of a visual inspection. In addition, air-sampling methods for some fungi are prone to false negative results and therefore cannot be used to definitively rule out contamination.
   b. Air monitoring may be necessary if an individual(s) has been diagnosed with a disease that is or may be associated with a fungal exposure (e.g., pulmonary hemorrhage/hemosiderosis, and aspergillosis).
   c. Air monitoring may be necessary if there is evidence from a visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building. It is preferable to conduct sampling while ventilation systems are operating.
   d. Air monitoring may be necessary if the presence of mold is suspected (e.g., musty odors) but cannot be identified by a visual inspection or bulk sampling (e.g., mold growth behind walls). The purpose of such air monitoring is to determine the location and/or extent of contamination.
   e. If air monitoring is performed, for comparative purposes, outdoor air samples shall be collected concurrently at an air intake, if possible, and at a location representative of outdoor air. For additional information on air sampling, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."
   f. Personnel conducting the sampling shall be trained in proper air sampling methods for microbial contaminants. A laboratory specializing in mycology shall be consulted for specific sampling and shipping instructions.
4. Analysis of Environmental Samples
   a. Microscopic identification of the spores/colonies requires considerable expertise. These services are not routinely available from commercial laboratories. Documented quality control in the laboratories used for analysis of the bulk/surface and air samples is necessary. The American Industrial Hygiene Association (AIHA) offers accreditation to microbial laboratories (Environmental Microbiology Laboratory Accreditation Program (EMLAP)). Accredited laboratories must participate in quarterly proficiency testing (Environmental Microbiology Proficiency Analytical Testing Program (EMPAT)).
5. Evaluation of bulk/surface and air sampling data shall be performed by an experienced health professional. The presence of few or trace amounts of fungal spores in bulk/surface sampling shall be considered background. Amounts greater than this or the presence of fungal fragments (e.g., hyphae, and conidiophores) may suggest fungal colonization, growth, and/or accumulation at or near the sampled location. Air samples shall be evaluated by means of comparison (i.e., indoors to outdoors) and by fungal type (e.g., genera, and species). In general, the levels and types of fungi found should be similar indoors (in non-problem buildings) as compared to the outdoor air. Differences in the levels or types of fungi found in air samples may indicate that moisture sources and resultant fungal growth may be problematic.

B. Remediation
1. General
   a. **In all situations, the underlying cause of water accumulation must be rectified or fungal growth will recur.** Any initial water infiltration shall be stopped and cleaned immediately. An immediate response (within 24 to 48 hours) and thorough clean up, drying, and/or removal of water damaged materials will prevent or limit mold growth. If the source of water is elevated humidity, relative humidity shall be maintained at levels below 60% to inhibit mold growth. Emphasis shall be on ensuring proper repairs of the building infrastructure, so that water damage and moisture buildup does not recur.
   b. Five different levels of abatement are described below. The size of the area impacted by fungal contamination primarily determines the type of remediation. The sizing levels below

are based on professional judgment and practicality; currently there is not adequate data to relate the extent of contamination to frequency or severity of health effects. **The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.** The listed remediation methods were designed to achieve this goal, however, due to the general nature of these methods it is the responsibility of the people conducting remediation to ensure the methods enacted are adequate. The listed remediation methods are not meant to exclude other similarly effective methods. Any changes to the remediation methods listed in these guidelines, however, shall be carefully considered prior to implementation.

c. Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are structurally sound and are visibly moldy can be cleaned and reused. Cleaning shall be done using a detergent solution. Porous materials such as ceiling tiles and insulation, and wallboards with more than a small area of contamination shall be removed and discarded. Porous materials (e.g., wallboard, and fabrics) that can be cleaned, can be reused, but should be discarded if possible. A professional restoration consultant shall be contacted when restoring porous materials with more than a small area of fungal contamination. All materials to be reused shall be dry and visibly free from mold. Routine inspections shall be conducted to confirm the effectiveness of remediation work.

d. The use of gaseous, vapor-phase, or aerosolized biocides for remedial purposes is **not** recommended. The use of biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space if used improperly. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mold. For additional information on the use of biocides for remedial purposes, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."

2. ***Level I***: **Small Isolated Areas** (10 sq. ft or less) - e.g., ceiling tiles, small areas on walls

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons recovering from recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).

d. Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.

e. Contaminated materials that cannot be cleaned shall be removed from the building in a sealed plastic bag. There are no special requirements for the disposal of moldy materials.

f. The work area and areas used by remedial workers for egress shall be cleaned with a damp cloth and/or mop and a detergent solution.

g. All areas shall be left dry and visibly free from contamination and debris.

3. ***Level II***: **Mid-Sized Isolated Areas** (10 - 30 sq. ft.) - e.g., individual wallboard panels.

a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
d. The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
e. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
f. Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
g. The work area and areas used by remedial workers for egress shall be HEPA vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) and cleaned with a damp cloth and/or mop and a detergent solution.
h. All areas shall be left dry and visibly free from contamination and debris.

4. ***Level III*: Large Isolated Areas** (30 - 100 square feet) - e.g., several wallboard panels.
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project.
   b. The following procedures *at a minimum* are recommended:
      1) Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      2) The work area and areas directly adjacent shall be covered with a plastic sheet(s) and taped before remediation, to contain dust/debris.
      3) Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
      4) The work area and areas directly adjacent shall be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and surrounding areas shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
   c. If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level IV are followed.

5. ***Level IV*: Extensive Contamination** (greater than 100 contiguous square feet in an area)
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Full-face respirators with high efficiency particulate air (HEPA) cartridges
         b) Disposable protective clothing covering both head and shoes
         c) Gloves
      2) Containment of the affected area:

a) Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
b) The use of an exhaust fan with a HEPA filter to generate negative pressurization
c) Airlocks and decontamination room

3) Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
4) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. The outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop with a detergent solution and be visibly clean prior to the removal of isolation barriers.
6) Air monitoring shall be conducted prior to occupancy to determine if the area is fit to reoccupy.

6. ***Level V***: Remediation of HVAC Systems
   a. A Small Isolated Area of Contamination (<10 square feet) in the HVAC System
      1) Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
      2) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      3) The HVAC system shall be shut down prior to any remedial activities.
      4) The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned shall be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and areas immediately surrounding the work area shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
      9) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.
   b. Areas of Contamination (>10 square feet) in the HVAC System: A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended.
         b) Gloves and eye protection

c) Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes shall be worn if contamination is greater than 30 square feet.

2) The HVAC system shall be shut down prior to any remedial activities.

3) Containment of the affected area:
   a) Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.
   b) The use of an exhaust fan with a HEPA filter to generate negative pressurization.
   c) Airlocks and decontamination room if contamination is greater than 30 square feet.

4) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.

5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.

6) All areas shall be left dry and visibly free from contamination and debris.

7) Air monitoring shall be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.

8) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.

7. Hazard Communication: When fungal growth requiring large-scale remediation is found, the building owner, management, and/or employer shall notify occupants in the affected area(s) of its presence. Notification shall include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to bioaerosol exposure should see their physicians for a referral to practitioners who are trained in occupational/environmental medicine or related specialties and are knowledgeable about these types of exposures. Individuals seeking medical attention shall be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

END OF SECTION 02 87 13 00

Task	Specification	Specification Description
02 87 13 33	02 87 13 00	Mold Remediation

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SECTION 02 87 16 13 - BIRD EXCREMENT REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for bird-excrement removal.

B. Related Requirements:

1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
2. Section 024296 "Historic Removal and Dismantling" for special requirements related to removing items from historic surfaces.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 PRECONSTRUCTION MEETINGS

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

1. Review minutes of Preliminary Historic Treatment Conference that pertain to protection of historic areas and surfaces.
2. Review methods and procedures related to excrement removal, including, but not limited to, the following:

a. Bird-excrement-removal specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Fire-protection plan.
d. Coordination with building occupants.
e. Dust and HVAC control.

1.5 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Preconstruction Test Reports: For removal materials and methods.

B. Qualification Statements: For [**bird-excrement-removal specialist**][**and**][**industrial hygienist**].

1.6 QUALITY ASSURANCE

A. Bird-Excrement-Removal Specialist Qualifications: A firm that employs personnel experienced and skilled in the processes and operations indicated.

B. Industrial Hygienist Qualifications: Certified as Industrial Hygienist by the American Board of Industrial Hygiene; having Bachelor's degree in industrial hygiene, public health, biological science, occupational health, or environmental and safety discipline; and experienced in work of types specified.

C. Regulatory Requirements: Comply with notification regulations of authorities having jurisdiction before beginning excrement-removal work. Comply with collection and disposal regulations of authorities having jurisdiction.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified bird-excrement-removal specialist to perform preconstruction testing on surfaces with accumulations of bird excrement.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

B. Preconstruction Testing: Performed by a qualified bird-excrement-removal specialist to demonstrate effects of removal work on substrate appearance and longevity and set quality standards for materials and execution.

1. Bird-Excrement Removal: Remove excrement from an area [**approximately 25 sq. ft.**][**as indicated**] for each type of [**cornice**][**coping**][**floor**][**and**][**wall**] substrate material.

a. Test chemicals and methods on samples of adjacent building materials for possible adverse reactions. Do not use chemicals and methods known to have deleterious effect.
b. Allow a waiting period of not less than seven days after completion of removal work to permit a study of test area for deleterious effects.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Select materials and methods of use based on the following, subject to preconstruction testing:

1. Previous effectiveness in performing the work involved.
2. Minimal possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
b. Leave residue on surfaces.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with temporary barrier and air quality control requirements in Section 015000 "Temporary Facilities and Controls."

B. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from excrement-removal procedures.

1. Use only proven protection methods, appropriate to each area and surface being protected.
2. Provide barricades, dustproof partitions, and temporary directional signage to exclude public from work areas.
3. Contain dust and debris generated by excrement-removal work and prevent it from reaching the public or adjacent surfaces.

C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.

3.2 BIRD-EXCREMENT REMOVAL

A. General: [**The Owner will engage**][**Engage**] a qualified industrial hygienist to perform tests, make recommendations, and observe the Work. Follow procedures required by authorities having jurisdiction and recommended by industrial hygienist.

B. Removing Bird Excrement: Have bird-excrement-removal Work performed by a qualified bird-excrement-removal specialist.[**Remove exterior bird-excrement accumulations with building windows and other openings in the building closed or sealed off.**][**Remove interior bird excrement with other parts of the building sealed off from work area and with windows and other openings to exterior areas accessible to the public closed or sealed off.**]

1. Use materials and follow procedures as determined by preconstruction testing.
2. Before removal, treat bird excrement to kill pathogens; dampen excrement to prevent particles becoming airborne.
3. Use only nonmetallic tools, such as plastic spatulas and brushes with natural fiber or nylon bristles.
4. Collect excrement as it is removed, seal it in durable plastic bags, and legally dispose of it off-site.
5. Repeat removal procedure above where required to produce cleaning effect established by preconstruction testing.

C. Removing Bird-Excrement Stain: Clean as required in Section pertaining to cleaning substrate material from which bird excrement was removed.

END OF SECTION 02 87 16 13

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Task	Specification	Specification Description
02 89 00 00	01 22 00 00	No Specification Required
02 89 00 00	02 83 00 00	Lead Remediation
02 89 00 00	02 83 19 00	Lead-Based Paint Remediation
02 89 00 00	02 83 19 00a	XRF Testing For Lead-Based Paint
02 89 00 00	02 83 19 00b	Lead Dust Wipe, Air And Tclp Sampling And Analysis
02 90 55 00	01 22 00 00	No Specification Required

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SECTION 05 01 70 51 - DECORATIVE METAL CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes decorative metal cleaning as follows:

1. Cleaning metal.
2. Removing paint
3. Removing corrosion.
4. Priming for repainting.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

B. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For decorative metal refinishing specialist.

B. Preconstruction Test Reports: For [**chemical cleaning of**][**and**][**paint removal from**] decorative metal.

1.6 QUALITY ASSURANCE

A. Decorative Metal Cleaning Specialist Qualifications: A qualified decorative metal cleaning specialist. Cleaning specialist shall be experienced in using mechanical and chemical methods on the types of

metal surfaces indicated.

1. Single Specialist: Subject to compliance with requirements, engage the same specialist firm to perform the work of [**Section 050170.61 "Decorative Metal Repair"**][**Section 050170.63 "Decorative Metal Refinishing"**] and the work of this Section.

B. Mockups: Prepare mockups of decorative metal cleaning processes[**on existing surfaces**] to demonstrate aesthetic effects and to set quality standards for materials and execution. Prepare mockups so they are inconspicuous.

1. Cleaning: Prepare an area [**approximately 2 sq. ft. (0.2 sq. m)**][**as indicated on Drawings**] for each process on each type of metal indicated for treatment.
2. Approval of mockups does not constitute approval of deviations from the Contract
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency or one or more [**chemical-cleaner**][**and**][**paint-remover**] manufacturers to perform preconstruction testing on each type of metal.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with decorative metal cleaning only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Nonacidic Liquid Chemical Cleaner: Manufacturer's standard mildly alkaline liquid cleaner, formulated for removing organic soiling from ordinary building materials, including polished stone, brick, copper, brass, bronze, aluminum, stainless steel, plastics, wood, and glass.

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

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Dumond Chemicals, Inc**]

E. Abrasive Materials:

1. Abrasive Pads for Copper-Alloy Cleaning: Extra-fine bronze wool or plastic abrasive pads.
2. Blasting Abrasive: [**Pulverized walnut shells**][**Powdered aluminum silicate**].
3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

2.2 PAINT REMOVERS

A. Alkaline-Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation for removing paint from metals, and containing no methylene chloride.

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

a. [**American Building Restoration Products, Inc.**]
b. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
c. [**EaCo Chem, Inc.**]

B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline paste or gel formulation for removing paint from metal, and containing no methylene chloride.

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

a. [**American Building Restoration Products, Inc.**]
b. [**Dumond Chemicals, Inc**]

C. Solvent-Type-Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation for removing paint from metals.

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

a. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
b. [**Shore Corporation**]

D. Low-Odor, Solvent-Type-Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable

solvent-type paste, gel, or foamed emulsion formulation for removing paint from metals; and containing no methanol or methylene chloride.

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

    a. [**American Building Restoration Products, Inc.**]
    b. [**Cathedral Stone Products, Inc.**]
    c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
    d. [**Dumond Chemicals, Inc**]
    e. [**EaCo Chem, Inc.**]

E. Covered, Solvent-Type-Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from masonry; and containing no methanol or methylene chloride.

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

    a. [**Dumond Chemicals, Inc**]

2.3 MISCELLANEOUS MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.

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

    a. [**American Building Restoration Products, Inc.**]
    b. [**Price Research, Ltd. dba Charles Paint Research**]

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces; and that will easily come off entirely, including adhesive.

C. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

a. Remove, alter, or in any way harm the present or future condition of existing surfaces, including surrounding surfaces not in the Contract.
b. Leave an unintended residue on surfaces.

2.4 FERROUS METAL PRIMERS

A. Repair Primer: Manufacturer's standard, rust-inhibiting, fast-curing, lead- and chromate-free, universal primer, compatible with[**firmly adhered existing paint and**] applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry-film thickness.

B. Finish Primer: Primer complying with applicable requirements in [**Section 090190.52 "Maintenance Repainting"**] for finish painting of primed metal.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of sufficient force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 DECORATIVE METAL CLEANING, GENERAL

A. Execution of the Work: In cleaning items, disturb them as minimally as possible and as follows:

1. Remove deteriorated coatings and corrosion.
2. Sequence work to minimize time before protective coatings are reapplied.
3. Clean items in place unless otherwise indicated.

B. Mechanical Coating Removal: Use gentle methods, such as scraping and wire brushing, that will not abrade metal substrate.

C. Repaint: Where indicated, prepare painted decorative metal by [**cleaning surface, removing less than firmly adhered existing paint, sanding edges smooth,**][**removing existing paint**] and priming for painting as specified.

3.3 CLEANING

A. General: Use those methods indicated for each type of decorative metal and its location.

1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

    a. Equip units with pressure gages.
    b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
    c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
    d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
    e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

B. Water Cleaning: Clean with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray. Supplement with [**natural-fiber**][**or**][**plastic**]-bristle brush. Use small brushes to remove soil from joints and crevices.

C. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution and [**natural-fiber**][**or**][**plastic**]-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure where needed to produce cleaning effect established by mockup.

D. Nonacidic Liquid Chemical Cleaning: Apply chemical cleaner to surfaces according to chemical-cleaner manufacturer's written instructions.

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of two to three minutes**].
4. Nonferrous Metals: Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Ferrous Metals: Do not rinse ferrous metals with water; neutralize chemical cleaner on ferrous metals as recommended in writing by manufacturer. Dry immediately with clean soft cloths. Follow direction of grain in metal.
6. Repeat cleaning procedure where needed to produce cleaning effect established by mockup. Do not repeat more than once.

E. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[**, leaving uniform patina intact,**] by light rubbing with abrasive pads and water. [**Rinse with cold water to remove residue. Apply rinse by low-pressure spray**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

F. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[**, leaving uniform patina intact,**] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [**Rinse with cold-water, low-pressure spray to remove residue**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

1. Pressure and Distance from Surface: Maximum pressure of [**60 psi (415 kPa)**][**100 psi (690 kPa)**][**200 psi (1375 kPa)**] with specified blasting abrasive propelled from a distance of [**6 to 12 inches (152 to 305 mm)**][**12 to 18 inches (305 to 457 mm)**] from surface.
2. Pressure and distance from surface as established by mockup.

G. Chemical Rust Removal:

1. Remove loose rust scale with approved abrasives for ferrous metal cleaning.
2. Apply rust remover with brushes or as recommended in writing by manufacturer.
3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

H. Mechanical Rust Removal:

1. Remove rust with approved abrasives for ferrous metal cleaning.
2. Wipe off residue with mineral spirits and either steel wool or soft rags.
3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.4 PAINT REMOVAL

A. General: Use only those paint-removal methods indicated for each type of decorative metal.

1. Application: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

   a. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks.
   b. After work is complete, remove protection no longer required. Remove tape and adhesive marks.

2. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
3. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

   a. Equip units with pressure gages.
   b. Unless otherwise indicated, hold spray nozzle at least **6 inches (152 mm)** from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous

strokes to produce uniform coverage.

c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with cone-shaped spray.
d. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
e. For high-pressure water-spray application, use fan-shaped spray tip that disperses water at an angle of at least 40 degrees.
f. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

B. Paint Removal with Alkaline-Paste Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted metal with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

C. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted metal with brushes or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
8. For spots of remaining paint, apply alkaline-paste paint remover according to "Paint Removal with Alkaline-Paste Paint Remover" Paragraph above.

D. Paint Removal with Solvent-Type-Paste Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to painted decorative metal with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

E. Paint Removal with Covered, Solvent-Type-Paste Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted decorative metal with natural-fiber cleaning brush, deep-nap roller, or large paint brush or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove remaining chemicals and paint residue.

3.5 PRIMING

A. Repair Primer: Apply immediately after completing a repair.

B. Finish Primer: Apply as soon after cleaning as possible.

3.6 DECORATIVE METAL CLEANING SCHEDULE

A. Treatment for Decorative Railing [**DMR-1**]: Wrought-iron railing and gate.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: [**Alkaline-paste paint remover**][**Covered or skin-forming alkaline paint remover**][**Solvent-type-paste paint remover**][**Low-odor, solvent-type-paste paint remover**][**Covered, solvent-type paint remover**].
3. Repairs: As specified in Section 050170.61 "Decorative Metal Repair."
4. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

B. Treatment of Decorative Railing [**DMR-2**]: Cast-iron balustrade.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: [**Alkaline-paste paint remover**][**Covered or skin-forming alkaline paint remover**][**Solvent-type-paste paint remover**][**Low-odor, solvent-type-paste paint remover**][**Covered, solvent-type-paste paint remover**].
3. Rust Removal: [**Chemical**][**Mechanical**].
4. Repair: As specified in Section 050170.61 "Decorative Metal Repair."
5. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

C. Treatment of Decorative Railing [**DMR-3**]: Bronze railing with bronze handrail.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: [**Water cleaning**][**Detergent cleaning**][**Chemical cleaning**][**Abrasive blasting**].
3. Repair: As specified in Section 050170.61 "Decorative Metal Repair."
4. Bronze Finish: [**Satin finish with statuary conversion coating on railing; satin hand-rubbed finish, lacquered, on handrail**].

D. Treatment for Bronze Grille [**DMG-#**]: Strip paint and coat grille.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: [**Solvent-type-paste paint remover**][**Low-odor, solvent-type-paste paint**

remover][**Covered, solvent-type-paste paint remover**].

3. Protective Coating: As specified in [**Section 050170.63 "Decorative Metal Refinishing."**]

END OF SECTION 05 01 70 51

SECTION 05 01 70 61 - DECORATIVE METAL REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative metal repairs as follows:

   a. Repairing metal and replacing damaged and missing components in place.
   b. Removing metal for shop repair and replacement of components; reinstalling repaired metal.
   c. Painting steel uncovered during the Work.
   d. Installing wood rails supported by or attached to decorative metal railings or brackets.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 057000 "Decorative Metal" for new decorative metal construction.
3. Section 057300 "Decorative Metal Railings" for new decorative handrails and railings.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**]

B. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, methods of attachment, accessory items, and finishes.
2. Include field-verified dimensions and the following:

a. Identification of each new metal item and component and its location on the structure in annotated plans and elevations.
b. Provisions for expansion, weep holes, and conduits as required for each location and exposure.
c. Provisions for sealant joints if required.

C. Samples for Initial Selection: For the following:

1. Each type of decorative metal item and component with applied finishes.
2. Sealant materials.
3. Accessories to verify color selection.

D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:

1. Each type of new material to be used for replacing existing or missing decorative metal; **6 inches (150 mm)** long in least dimension or whole item.
2. Fittings and brackets.
3. Each type of exposed connection between components. Show method of finishing components at connections.
4. Each type of exposed finish prepared on metal of the same alloy to be used for the Work of this Section; **6 inches (150 mm)** long in least dimension.
5. Sealant materials.
6. Accessories: Each type of anchor, accessory, and miscellaneous support in required finishes.

E. Delegated-Design Submittal: For [**structural performance of repaired railings, handrails, and anchors**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For decorative metal repair specialist.

B. Evaluation Reports: For post-installed structural anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Decorative Metal Repair Specialist Qualifications: A qualified decorative metal fabrication and repair specialist. Experience installing and finishing new decorative metalwork is insufficient experience for repairing decorative metal.

1. Single Specialist: Subject to compliance with requirements, engage the same specialist firm to perform the work of [**Section 050170.51 "Decorative Metal Cleaning"**][**Section 050170.63 "Decorative Metal Refinishing"**] and the work of this Section.

B. Mockups: Prepare mockups of decorative metal repair processes[**on existing surfaces**] to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation. Prepare mockups so they are inconspicuous.

1. Replacing Cast-Metal Components: [**Two**] cast-iron [**handrail brackets**][**and**][**grilles**] replaced with exact duplicates.
2. Replacing Cut-Out Metal Items: [**Two**] cut-out bronze-plate [**wall registers**] replaced with exact duplicates.

3. Repairing Wrought Handrail and Railing: [**3 feet (1 m)**] of wrought-iron handrail and railing. [**Patch indentations and reconnect fractures by filling, welding, brazing, or applying new metal material**].
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Pack, deliver, and store decorative metal items in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, cracked, or otherwise damaged.

B. Store decorative metal inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

C. Protect strippable protective covering on decorative metal from exposure to sunlight and high humidity, except to the extent necessary for the period of decorative metal installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with decorative metal repairs only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design post-installed structural anchors.

B. Structural Performance: [**Railings**][**and**][**handrails**], including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
2. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
3. Uniform and concentrated loads need not be assumed to act concurrently.

2.2 METAL MATERIALS

A. General: Provide decorative metal materials made of the alloys, forms, and types that match existing metals and have the ability to receive finishes matching existing finishes unless otherwise indicated. Exposed-to-view surfaces exhibiting imperfections inconsistent with existing materials are unacceptable.

B. Source Limitation for Replacement Cast Materials: Obtain castings for decorative metal repair from single source from single manufacturer with resources to provide materials of consistent quality in appearance and physical properties.

C. Aluminum: Alloy and temper recommended in writing by aluminum producer and finisher for type of use

and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required:

1. Extruded Bars and Shapes: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.
2. Extruded Structural Pipe and Tubes: ASTM B429/B429M, Alloy 6063-T6.
3. Drawn General-Purpose Seamless Tubes: **ASTM B210 (ASTM B210M)**, Alloy 6063-T832.
4. Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.
5. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.
6. Castings: ASTM B26/B26M, Alloy A356-T6.

D. Copper Alloys, Bronze: Copper alloy designated below for each form required:

1. Extruded Shapes: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze, 57 percent copper and 40 percent zinc).
2. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper and 40 percent zinc).
3. Seamless Pipe: ASTM B43, Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
4. Seamless Tubes: **ASTM B135 (ASTM B135M)**, Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
5. Composition Bronze Castings: ASTM B62, Alloy UNS No. C83600 ("85-5-5-5" is the common trade name; 85 percent copper and 5 percent each of tin, lead, and zinc).
6. Sand Castings: ASTM B584, Alloy UNS No. C86500 (No. 1 manganese bronze, 58 percent copper, 39 percent zinc, 1 percent manganese, and small amounts of other metals).

E. Copper Alloys, Brass: Copper alloy designated below for each form required:

1. Extruded Shapes: ASTM B249/B249M, Alloy UNS No. C36000 (free-cutting brass, 60 percent copper, 36 percent zinc, and small amounts of other metals).
2. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
3. Seamless Tubes: **ASTM B135 (ASTM B135M)**, Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
4. Sand Castings: ASTM B584, Alloy UNS No. C85200 (high-copper yellow brass, 72 percent copper, 24 percent zinc, and small amounts of other metals).

F. Stainless Steel: Grade designated below for each form required:

1. Tubing: ASTM A554, [**Grade MT-304**][**Grade MT-316**].
2. Pipe: ASTM A312/A312M, [**Grade TP304**][**Grade TP316**].
3. Castings: ASTM A743/A743M, [**Grade CF8 or CF20**][**Grade CF8M**].
4. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].
5. Flat Bar: ASTM A666, [**Type 304**][**Type 316**].
6. Bars and Shapes: ASTM A276, [**Type 304**][**Type 316**].

G. Steel: Standard and grade designated below for each form required:

1. Tubing: Cold formed, ASTM A500/A500M.
2. Steel Plate, Shapes, and Bars: ASTM A36/A36M.
3. Steel Bars: Mild steel; ASTM A29/A29M, Grade 1010.
4. Steel Sheet: ASTM A1008/A1008M, cold-rolled commercial steel sheet; matte finish; suitable for exposed applications.

H. Cast Iron: Standard designated below for each type of casting:

1. Gray-Iron Castings: ASTM A48/A48M, Class 30.
2. Malleable-Iron Castings: ASTM A47/A47M, grade as recommended in writing by fabricator for type of use indicated.

I. Wrought Iron: [**Mild steel; ASTM A29/A29M, Grade 1010**]; hand worked or machine forged to the form indicated.

2.3 PREPARATORY CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Abrasive Materials:

1. Abrasive Pads for Copper-Alloy Cleaning: Extra-fine bronze wool or plastic abrasive pads.
2. Blasting Abrasive: [**Pulverized walnut shells**][**Powdered aluminum silicate**].
3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

E. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

F. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to [**MPI #23 (surface-tolerant, anticorrosive metal primer)**][**or**][**SSPC-Paint 20 or SSPC-Paint 29**].

1. Surface Preparation: Use coating requiring no better than [**SSPC-SP 2, "Hand Tool Cleaning"**][**SSPC-SP 3, "Power Tool Cleaning"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"**] surface preparation according to manufacturer's literature or certified statement.
2. VOC Limit: Use coating with a VOC content of [**400 g/L (3.3 lb/gal.)**] or less.

2.4 FASTENERS

A. Fasteners: Fasteners of the same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal joined.

1. Match existing fasteners in material and in type of fastener unless otherwise indicated.
2. Use concealed fasteners for interconnecting decorative metal components and for attaching them to other work unless exposed fasteners are [**unavoidable**][**or**][**the existing fastening method**].
3. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
4. Finish heads of exposed fasteners to match finish of metal fastened unless otherwise indicated.

B. Anchors, General: Use bolt heads of same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal anchored.

C. Post-Installed Structural Anchors: Fastener systems; with working capacity greater than or equal to the

design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [**AC01**][**AC193**][**AC58**][**or**][**AC308**] as appropriate for the substrate.

1. Uses: Securing [**railings**][**and**][**handrails**] to concrete.
2. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

D. Post-Installed Nonstructural Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [**AC01**][**AC193**][**AC58**][**or**][**AC308**] as appropriate for the substrate.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Wood Rails: Hardwood rails of species and profile [**matching design reference sample**][**matching existing**][**as indicated on Drawings**], complying with [**Section 064013 "Exterior Architectural Woodwork."**][**Section 064023 "Interior Architectural Woodwork."**].

B. Welding Electrodes and Filler Metal: Select according to AWS specifications for metal alloy welded; use metal type and alloy as recommended in writing by producer of metal to be welded or filled and as required for color match, strength, and compatibility in fabricated items.

C. Brazing Rods for Copper-Alloy Components: Type and alloy as recommended in writing by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

D. Brazing Rods for Cast-Iron Components: Type and alloy as recommended in writing by brazing-rod manufacturer and as required for strength and compatibility in fabricated items.

E. Metal-Patching Compound: Two-part, polyester-resin metal-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of metal repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling metal that has deteriorated because of corrosion. Filler shall be capable of filling deep holes and spreading to feather edge.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended in writing by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: [**At exterior locations**][**and**][**where indicated**], provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior use.

H. Sealant Materials:

1. Provide manufacturer's standard, elastomeric [**single-component, nonsag, neutral-curing silicone**][**single-component, nonsag urethane**] sealant complying with applicable requirements in Section 079200 "Joint Sealants."
2. Colors: Provide colors of exposed sealants to match colors of metals in which sealant is placed unless otherwise indicated.

I. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.

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

a. [**American Building Restoration Products, Inc.**]
b. [**Price Research, Ltd. dba Charles Paint Research**]

J. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces, and that will easily come off entirely, including adhesive.

K. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

a. Remove, alter, or in any way harm the present or future condition of existing surfaces, including surrounding surfaces not in the Contract.
b. Leave an unintended residue on surfaces.

2.6 METAL FABRICATION

A. Metal Fabricators:

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

a. [**Allen Architectural Metals, Inc**]
b. [**Alloy Casting Co., Inc.**]
c. [**Antique Cast Iron, LLC**]
d. [**Architectural Iron Company, Inc.**]
e. [**Brandywine Forge**]
f. [**f2 Industries**]
g. [**Heritage Cast Iron USA**]
h. [**Historical Arts & Casting, Inc**]
i. [**King Architectural Metals**]

j. [**Olek Lejbzon & Co.**]
k. [**Postville Blacksmith Shop**]
l. [**Robinson Iron**]
m. [**Schiff Architectural Detail**]
n. [**Wiemann Metalcraft**]

B. Fabricate repairs of decorative metal items and components in sizes and profiles to match existing decorative metal, with accurate curves, lines, and angles. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

C. Provide uniform, neat seams with minimum exposure of welds, brazing, solder, and sealant.

D. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for fasteners. Use concealed fasteners where possible; use exposed fasteners to match existing work.

E. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.

1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
2. Remove flux immediately.
3. At exposed connections, match contours of adjoining surfaces, and finish exposed surfaces smooth and blended so no roughness shows after finishing.

F. Castings: Fabricate castings free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

1. Finish castings to match existing decorative metalwork.
2. Replacement Casting for Handrail Bracket: Duplicate existing handrail bracket on the cast-iron railing of first-floor stairs in the lobby. Make molds from this bracket to create new cast-iron brackets.

2.7 FINISHES, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

C. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

2.9 COPPER-ALLOY FINISHES

A. General: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)."

B. Buffed Finish: [**M21 (Mechanical Finish: buffed, smooth specular)**][**M22 (Mechanical Finish: buffed, specular)**].

C. Buffed Finish, Lacquered: [**M22 (Mechanical Finish: buffed, specular; specified clear organic coating)**].

D. Satin Hand-Rubbed Finish: [**M32-M34 (Mechanical Finish: directionally textured, medium satin and hand rubbed)**].

E. Satin Hand-Rubbed Finish, Lacquered: [**M32-M34-06x (Mechanical Finish: directionally textured, medium satin and hand rubbed; specified clear organic coating)**].

F. Satin Finish with Statuary Conversion Coating: [**M32-C55 (directionally textured, medium satin; sulfide conversion coating)**].

1. Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**]

G. Brushed Finish with Patina Conversion Coating: M35-C12-C52 (directionally textured, rotary brushed and buff polished, nonetched cleaned; ammonium sulfate conversion coating).

1. Texture and Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

H. Bright-Relieved Statuary Conversion Coating, Lacquered: M12-C55-M2x-06x (matte finish as cast; sulfide conversion coating; buffed to brighten high spots; specified clear organic coating):

1. Color and Buffing: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

2.10 FERROUS METAL FINISHES

A. Repair Primer: Manufacturer's standard, rust-inhibiting, fast-curing, lead- and chromate-free universal primer, compatible with[**firmly adhered existing paint and**] applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

B. Finish Primer: Primer complying with applicable requirements in [**Section 090190.52 "Maintenance Repainting"**] for finish painting of primed existing metal.

C. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning,

pretreatment, application, and minimum dry film thickness.

2.11 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines from new replacement stainless steel, or blend into finish.

B. Restored Finish: Grind and polish surfaces to produce uniform, directionally textured, polished finish to match [**existing finish**][**Architect's sample**], free of cross scratches.

1. Run grain to match existing metal.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M, No. 4.
4. Dull Satin Finish: ASTM A480/A480M, No. 6.
5. Reflective, Directional Polish: ASTM A480/A480M, No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M, No. 8.

D. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proved to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 DECORATIVE METAL REPAIR, GENERAL

A. Repair Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from [**20 feet (6 m)**][**50 feet (15 m)**] away by Architect.

B. Execution of the Work: In repairing items, disturb remaining existing work as minimally as possible and as follows:

1. Stabilize decorative metal to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
2. Remove deteriorated coatings and corrosion.
3. Sequence work to minimize time before protective coatings are reapplied.
4. Repair items where stabilization is insufficient to stop progress of deterioration.
5. Repair items in place where possible.
6. Replace or reproduce items where indicated or scheduled.
7. Install temporary protective measures to stabilize decorative metal that is indicated to be repaired later.

C. Mechanical Coating Removal: Use gentle methods, such as scraping and wire brushing, that will not abrade metal substrate.

D. Repair Decorative Metal Item: Match existing materials and features.

1. Repair decorative metals by patching, piecing-in, splicing, or otherwise reinforcing metals with new metal matching existing metal.

E. Replace Decorative Metal Component: Where indicated, duplicate and replace items with new metal matching existing metal.

1. Replace heavily deteriorated or missing parts or features of decorative metal with compatible materials, using surviving prototypes to create patterns or molds for duplicate replacements.

3.3 PREPARATORY CLEANING

A. General: Use those methods indicated for each type of decorative metal and its location.

1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being cleaned. Use brushes that are resistant to chemicals being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

    a. Equip units with pressure gages.
    b. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
    c. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
    d. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

B. Water Cleaning: Clean with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray. Supplement with [**natural-fiber**][**or**][**plastic**]-bristle brush. Use small brushes to remove soil from joints and crevices.

C. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution and [**natural-fiber**][**or**][**plastic**]-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.

D. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by light rubbing with abrasive pads and water. [**Rinse with cold water to remove residue. Apply rinse by low-pressure spray**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

E. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [**Rinse with cold-water, low-pressure spray to remove residue**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

1. Pressure and Distance from Surface: Maximum pressure of [**60 psi (415 kPa)**][**100 psi (690 kPa)**][**200 psi (1375 kPa)**] with specified blasting abrasive propelled from a distance of [**6 to 12 inches (152 to 305 mm)**][**12 to 18 inches (305 to 457 mm)**] from surface.
2. Pressure and distance from surface as established by mockup.

F. Chemical Rust Removal:

1. Remove loose rust scale with approved abrasives for ferrous metal cleaning.
2. Apply rust remover with brushes or as recommended in writing by manufacturer.
3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

G. Mechanical Rust Removal:

1. Remove rust with approved abrasives for ferrous metal cleaning.
2. Wipe off residue with mineral spirits and either steel wool or soft rags.
3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.4 REMOVAL, REPAIR, AND REINSTALLATION

A. General: Perform removal work as required in Section 024119 "Selective Demolition" for specific requirements relating to selectively demolishing construction, including decorative metal removal for repair or reinstallation elsewhere.

B. Defects in Painted Metal Surfaces: Repair nonload-bearing defects in existing metal surfaces, including dents and gouges more than [**1/16 inch (1.6 mm)**][**1/8 inch (3 mm)**] deep or [**1/2 inch (13 mm)**][**1 inch (25 mm)**] across, and all holes and cracks by filling with metal-patching compound and sanding smooth. Remove burrs and protruding fasteners. Prime iron and steel surfaces immediately after repair to prevent flash rusting.

C. Reinstalling [**Railing**][**and**][**Fence**] Posts: After posts have been inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave **1/8-inch (3-mm)** buildup sloped away from post.

D. Anchoring Wood Rails: Secure wood rails to metal subrail or brackets from bottom of wood rail as indicated on Drawings. Make fastener heads flush to metal surface.

E. Installing Sealant:

1. After metal reinstallation, keep joints to receive sealant dry and free of debris.
2. Clean and prepare joint surfaces according to Section 079200 "Joint Sealants."[**Prime joint surfaces unless sealant manufacturer recommends against priming.**] Do not allow primer to spill or migrate onto adjoining surfaces.
3. Fill sealant joints with specified joint sealant as recommended in writing by sealant manufacturer and according to Section 079200 "Joint Sealants" and the following:

    a. Install sealant using only proved installation methods that ensure sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding metal.
    b. Do not allow sealant to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining surfaces, particularly rough or sculptural textures. Promptly remove excess and spillage of sealant as the work progresses. Clean adjoining surfaces by means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

4. Cure sealant according to Section 079200 "Joint Sealants."

3.5 PRIMING

A. Repair Primer: Apply immediately after completing a repair.

B. Finish Primer: Apply as soon after cleaning as possible.

3.6 PAINTING STEEL UNCOVERED DURING THE WORK

A. Notify Architect if steel is exposed during metal removal. Where Architect determines that the steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Surface Preparation: Remove paint, rust, and other contaminants according to [**SSPC-SP 2, "Hand Tool Cleaning,"**][**SSPC-SP 3, "Power Tool Cleaning,"**][**or**][**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning,"**] as applicable to comply with paint manufacturer's recommended preparation.
2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than [**1/16 inch (1.6 mm)**], notify Architect before proceeding, as directed by the Owner.

3.7 DECORATIVE METAL REPAIR SCHEDULE

A. Treatment for Decorative Railing [**DMR-1**]: Wrought-iron railing and gate.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Repairs: Repair railing and replace missing components with hand-worked [**steel bars**][**wrought iron**].

    a. Apply repair primer immediately after repair.

4. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]
5. Baked-Enamel or Powder-Coat Finish: [**Color as indicated by manufacturer's designations**][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**]

B. Treatment of Decorative Railing [**DMR-2**]: Cast-iron balustrade.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Rust Removal: [**Chemical**][**Mechanical**].
4. Repair: [**Patch with new material by filling, welding, brazing, or applying new metal material with fasteners**].

    a. Apply repair primer immediately after repair.

5. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

C. Treatment of Decorative Railing [**DMR-3**]: Bronze railing with bronze handrail.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Repair: [**Splice new material into deteriorated section**].
4. Bronze Finish: [**Satin finish with statuary conversion coating on railing; satin hand-rubbed finish, lacquered, on handrail**].

D. Treatment of Decorative Railing and Handrail [**DMRH-1**]: Deteriorated bronze handrail on cast-iron railing.

1. Repair: Replace broken cast-iron railing components and repaint railing. Replace entire, deteriorated bronze handrail with shop-fabricated aluminum handrail.
2. Paint Removal: As specified in Section 050170.51 "Decorative Metal Cleaning."
3. Railing Finish: Paint as specified in [**Section 090190.52 "Maintenance Repainting."**]

    a. Color: [**As indicated by manufacturer's designations**][**Matching design reference sample**][**Matching Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Handrail Finish:

    a. Aluminum Finish: [**Light bronze anodized**][**Medium bronze anodized**][**Dark bronze anodized**][**Anodized color matching design reference sample**][**Anodized color matching Architect's sample**][**Anodized color as selected by Architect from full range of industry colors and color densities**].
    b. Baked-Enamel or Powder-Coat Finish: [**Color as indicated by manufacturer's**

designations][**Color matching design reference sample**][**Color matching Architect's sample**][**Color as selected by Architect from manufacturer's full range**].

5. Finish Treatment:

   a. Protective Coating: As specified in Section 050170.63 "Decorative Metal Refinishing."
   b. Painted Finish: As specified in [**Section 090190.52 "Maintenance Repainting."**]

END OF SECTION 05 01 70 61

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SECTION 05 01 70 63 - DECORATIVE METAL REFINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes refinishing bare decorative metal surfaces as follows:

1. Refinishing metal in place.
2. Removing metal for shop refinishing; reinstalling refinished metal.
3. Integral metal finishes.
4. Clear protective coatings.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 099423 "Gilding" for gilding on metalwork.

1.2 DEFINITIONS

A. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

B. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

C. High-Pressure Spray: [**800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**].

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, and sections showing locations and extent of refinishing work.
2. Include field-verified dimensions.

C. Samples for Initial Selection: For the following:

1. A range of each type of exposed finish prepared on metal of the same alloy matching existing metal.

D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise

indicated, finished as required for use in the Work:

1. Each type of exposed finish prepared on metal of the same alloy matching existing metal; **6 inches (150 mm)** long in least dimension.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For decorative metal refinishing specialist.

1.6 QUALITY ASSURANCE

A. Decorative Metal Refinishing Specialist Qualifications: A qualified decorative metal refinishing specialist.

1. Single Specialist: Subject to compliance with requirements, engage the same specialist firm to perform the work of [**Section 050170.51 "Decorative Metal Cleaning"**][**Section 050170.61 "Decorative Metal Repair"**] and the work of this Section.

B. Mockups: Prepare mockups of decorative metal refinishing processes[**on existing surfaces**] to demonstrate aesthetic effects and to set quality standards for materials and execution. Prepare mockups so they are inconspicuous.

1. Waxing Bronze: Wax a cleaned area [**approximately 2 sq. ft. (0.2 sq. m)**][**as indicated on Drawings**] of [**each type of**] bronze [**sculpture**][**paneling**][**and**][**hardware**].
2. Refinishing Decorative Metal: Refinish [**one**] decorative for each type of metal indicated to be refinished.
3. Repairing Decorative Metal Finish: Repair finish of [**one**] decorative for each type of metal finish indicated to be repaired.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Pack, deliver, and store decorative metal items in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, cracked, or otherwise damaged.

B. Store decorative metal inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

C. Protect strippable protective covering on decorative metal from exposure to sunlight and high humidity, except to the extent necessary for the period of decorative metal installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with decorative metal refinishing only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 PREPARATORY CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution, Job Mixed: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent, and **20 quarts (20 L)** of hot water for every **5 gal. (20 L)** of solution required.

D. Nonacidic Liquid Chemical Cleaner: Manufacturer's standard mildly alkaline liquid cleaner, formulated for removing organic soiling from ordinary building materials, including polished stone, brick, copper, brass, bronze, aluminum, stainless steel, plastics, wood, and glass.

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

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Dumond Chemicals, Inc**]

E. Abrasive Materials:

1. Abrasive Pads for Copper-Alloy Cleaning: Extra-fine bronze wool or plastic abrasive pads.
2. Blasting Abrasive: [**Pulverized walnut shells**][**Powdered aluminum silicate**].
3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

2.2 PROTECTIVE COATING MATERIALS

A. Wax Coating: Inert, high-melting-point wax or wax blend, consisting primarily of [**carnauba**][**or**][**microcrystalline petroleum**] wax[**and no solvents**].

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

a. [**BWC Company, Inc. (The)**]
b. [**Fisher Scientific; part of Thermo Fisher Scientific**]
c. [**Real Milk Paint Co.**]
d. [**TALAS**]

B. Organic Coating: Clear, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of methyl methacrylate copolymer with benzotriazole UV inhibitor.

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

    a. [**StanChem, Inc.**]
    b. [**TALAS**]

C. Copper-Alloy Corrosion Inhibitor: Solution of [**1**][**to**][**3**] percent benzotriazole in water.

2.3 MISCELLANEOUS MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.

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

    a. [**American Building Restoration Products, Inc.**]
    b. [**Price Research, Ltd. dba Charles Paint Research**]

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces, and that will easily come off entirely, including adhesive.

C. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:

    a. Remove, alter, or in any way harm the present or future condition of existing surfaces, including surrounding surfaces not in the Contract.
    b. Leave an unintended residue on surfaces.

2.4 FINISHES, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

A. Unfinished: No applied finish; only preparatory cleaning.

B. Clear Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

C. Color Anodic Finish: AAMA 611, [**Class I, 0.018 mm**][**Class II, 0.010 mm**] or thicker over a [**satin (directionally textured)**][**polished (buffed)**][**nonspecular as fabricated**] mechanical finish.

2.6 COPPER-ALLOY FINISHES

A. General: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)."

B. Buffed Finish: [**M21 (Mechanical Finish: buffed, smooth specular)**][**M22 (Mechanical Finish: buffed, specular)**].

C. Buffed Finish, Lacquered: [**M22 (Mechanical Finish: buffed, specular; specified clear organic coating)**].

D. Satin Hand-Rubbed Finish: [**M32-M34 (Mechanical Finish: directionally textured, medium satin and hand rubbed)**].

E. Satin Hand-Rubbed Finish, Lacquered: [**M32-M34-06x (Mechanical Finish: directionally textured, medium satin and hand rubbed; specified clear organic coating)**].

F. Satin Finish with Statuary Conversion Coating: [**M32-C55 (directionally textured, medium satin; sulfide conversion coating)**].

1. Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

G. Brushed Finish with Patina Conversion Coating: M35-C12-C52 (directionally textured, rotary brushed and buff polished, nonetched cleaned; ammonium sulfate conversion coating).

1. Texture and Color: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

H. Bright-Relieved Statuary Conversion Coating, Lacquered: M12-C55-M2x-06x (matte finish as cast; sulfide conversion coating; buffed to brighten high spots; specified clear organic coating):

1. Color and Buffing: [**Match design reference sample**][**Match existing**][**Match Architect's sample**].

2.7 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines from new replacement stainless steel, or blend into finish.

B. Restored Finish: Grind and polish surfaces to produce uniform, directionally textured, polished finish to match [**existing finish**][**Architect's sample**], free of cross scratches.

1. Run grain to match existing metal.

2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: ASTM A480/A480M, No. 4.
4. Dull Satin Finish: ASTM A480/A480M, No. 6.
5. Reflective, Directional Polish: ASTM A480/A480M, No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M, No. 8.

PART 3 - EXECUTION

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proved to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 DECORATIVE METAL REFINISHING, GENERAL

A. Refinishing Appearance Standard: Refinished surfaces are to have a uniform appearance as viewed from [**20 feet (6 m)**][**50 feet (15 m)**] away by Architect.

B. Execution of the Work: In refinishing items, disturb remaining existing work as minimally as possible and as follows:

1. Remove dirt and corrosion.
2. Sequence work to minimize time before protective coatings are reapplied.
3. Refinish items in place where possible and according to required appearance.

C. Refinish Decorative Metal Item: Remove existing metal finishes on item unless otherwise indicated[**including integral polished and patinated finishes,**] and reapply them.

D. Repair Finish of Decorative Metal Item: Restore areas of deteriorated or missing finish on item and blend restored finish with existing, adjacent finish[**including integral polished and patinated finishes**].

3.3 PREPARATORY CLEANING

A. General: Use those methods indicated for each type of decorative metal and its location.

1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

    a. Equip units with pressure gages.
    b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
    c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
    d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
    e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

B. Water Cleaning: Clean with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray. Supplement with [**natural-fiber**][**or**][**plastic**]-bristle brush. Use small brushes to remove soil from joints and crevices.

C. Detergent Cleaning:

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Scrub surface with detergent solution and [**natural-fiber**][**or**][**plastic**]-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove detergent solution and soil.

D. Nonacidic Liquid Chemical Cleaning: Apply chemical cleaner to surfaces according to chemical-cleaner manufacturer's written instructions.

1. Wet surface with [**cold**][**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface[**in two applications**] by brush[**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**][**established by mockup**][**of two to three minutes**]
4. Nonferrous Metals: Rinse with [**cold**][**hot**] water applied by [**low**][**medium**][**high**]-pressure spray to remove chemicals and soil.
5. Ferrous Metals: Do not rinse ferrous metals with water; neutralize chemical cleaner on ferrous metals as recommended in writing by manufacturer. Dry immediately with clean soft cloths. Follow direction of grain in metal.

E. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by light rubbing with abrasive pads and water. [**Rinse with cold water to remove residue. Apply rinse by low-pressure spray**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove**

residue].

F. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[**leaving uniform patina intact,**] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [**Rinse with cold water, low-pressure spray to remove residue.**][**Do not rinse ferrous metals with water; wipe with damp cloths to remove residue**].

1. Pressure and Distance from Surface: Maximum pressure of [**60 psi (415 kPa)**][**100 psi (690 kPa)**][**200 psi (1375 kPa)**] with specified blasting abrasive propelled from a distance of [**6 to 12 inches (152 to 305 mm)**][**12 to 18 inches (305 to 457 mm)**] from the surface.
2. Pressure and distance from surface as established by mockup.

3.4 PROTECTIVE COATING

A. Protective Hot-Wax Coating:[**Pretreat cleaned copper-alloy surfaces with copper-alloy corrosion inhibitor, wipe off excess with ethanol-saturated rag, and allow surface to dry. If fresh corrosion appears, repeat process.**] Apply wax coating to produce uniform appearance without runs or other surface imperfections.

1. Clean and dry surface being waxed.
2. Preheat surface to about **212 deg F (100 deg C)**; hot enough to melt the wax and remove water vapor and other gases within metal surface, but not hot enough to boil the wax or ignite solvents if any.
3. Apply uniform wax coating to surface, ensuring that wax coverage is complete, including recesses.[**Apply second wax coating following the same process.**]
4. Inspect surface and repair holidays by reheating and applying more wax.
5. Buff waxed surface to a slight shine with a lint-free cloth after wax has cooled to a hazy appearance.

B. Protective Organic Coating:[**Pretreat cleaned copper-alloy surfaces with copper-alloy corrosion inhibitor, wipe off excess with ethanol-saturated rag, and allow surface to dry. If fresh corrosion appears, repeat process.**] Apply organic coating to produce uniform appearance without runs or other surface imperfections.

1. Clean and dry surface being coated.
2. Apply two uniform coats by air-spray method according to manufacturer's written instructions, with interim drying between coats.
3. Apply coating to a total dry film thickness of **1 mil (0.025 mm)**.
4. Protect coated surface from contamination until fully cured.

3.5 REMOVAL, REPAIR, AND REINSTALLATION

A. General: Perform removal, repair, and reinstallation work as required in Section 024119 "Selective Demolition" and Section 050170.61 "Decorative Metal Repair."

3.6 DECORATIVE METAL REFINISHING SCHEDULE

A. Treatment of Decorative Handrail [**DMR-#**] : Tarnished bronze railing with bronze handrail.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: [**Water cleaning**][**Detergent cleaning**][**Chemical cleaning**][**Abrasive blasting**].
3. Bronze Finish: [**Satin finish with statuary conversion coating on railing; satin hand-rubbed**

finish, lacquered, on handrail].

B. Treatment for Bronze Statue Finish [**DMS-#**]: Clean, repair patina finish, and coat statue.

1. General: Perform work [**in the shop**][**or**][**in the field**].
2. Cleaning: [**Water cleaning**][**Detergent cleaning**][**Chemical cleaning**][**Abrasive blasting**].
3. Finish Repair: Selectively patinate the [**nose**][**foot**][**and**][**previous metal repairs**] to match the rest of the statue.
4. Protective Coating: Protective [**hot-wax**][**organic**] coating.

END OF SECTION 05 01 70 63

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SECTION 05 05 19 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Prefabricated building columns.
3. Shelf angles.
4. Metal ladders.
5. Alternating tread devices.
6. Metal ships' ladders and pipe crossovers.
7. Metal floor plate.
8. Elevator pit sump covers.
9. Structural-steel door frames.
10. Miscellaneous steel trim.
11. Metal bollards.
12. Vehicular barrier cable systems.
13. Pipe and downspout guards.
14. Abrasive metal nosings, treads, and thresholds.
15. Cast-iron wheel guards.
16. Metal downspout boots.
17. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
3. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Requirements:

1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
3. Section 077200 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Fasteners.
3. Shop primers.
4. Shrinkage-resisting grout.
5. Prefabricated building columns.
6. Slotted channel framing.
7. Manufactured metal ladders.
8. Alternating tread devices.
9. Metal ships' ladders and pipe crossovers.
10. Metal bollards.
11. Vehicular barrier cable systems.
12. Pipe and downspout guards.
13. Abrasive metal nosings, treads, and thresholds.
14. Cast-iron wheel guards.
15. Metal downspout boots.

B. Shop Drawings: Show fabrication and installation details.[**Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.**] Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
2. Elevator machine beams, hoist beams, and divider beams.
3. Steel shapes for supporting elevator door sills.
4. Steel girders for supporting wood frame construction.
5. Steel pipe columns for supporting wood frame construction.
6. Prefabricated building columns.
7. Shelf angles.
8. Metal ladders.
9. Alternating tread devices.
10. Metal ships' ladders and pipe crossovers.
11. Metal floor plate and supports.
12. Elevator pit sump covers.
13. Structural-steel door frames.
14. Miscellaneous steel trim including [**steel angle corner guards**][**steel edgings**][**and**][**loading-dock edge angles**].
15. Metal bollards.
16. Loose steel lintels.
17. Vehicular barrier cable systems.

C. Samples for Verification: For each type and finish of extruded [**nosing**][**and**][**tread**].

D. Delegated Design Submittals: For [**ladders**][**alternating tread devices**][**and**][**vehicular barrier cable systems**], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.
12. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
13. Health Product Declaration (HPD): For each product.
14. Health Product Declaration (HPD): Provide HPD.
15. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.4 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research Reports: For post-installed anchors.

E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**ladders**][**alternating tread devices**][**and**][**vehicular barrier cable systems**].

B. Structural Performance of Aluminum Ladders: Ladders[**, including landings,**] are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.

C. Structural Performance of Alternating Tread Devices: Alternating tread devices are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Comply with applicable railing loadings in Section 055213 "Pipe and Tube Railings."

D. Vehicular Barrier Cable Systems: Design vehicular barrier cable systems to resist a single [**6000-lbf (28.7-kN)**] service load and [**10,000-lbf (47.9-kN)**] ultimate load applied horizontally in any direction to the cable system, with anchorages or attachments capable of transferring this load to the structure. Limit deflection to **18 inches (457 mm)**. Design is to assume loads are applied at a height of [**18 inches (457 mm)**] above the floor or ramp surface on an area not to exceed **1 sq. ft. (0.09 sq. m)**.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C)**, **ambient; 180 deg F (100 deg C)**, **material surfaces**].

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

E. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

F. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles**

(800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Regional Materials: Products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

H. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

I. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**].

J. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

K. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

L. Rolled-Stainless Steel Floor Plate: ASTM A793.

M. Abrasive-Surface Floor Plate: Steel plate [**with abrasive granules rolled into surface**][**or**][**with abrasive material metallically bonded to steel**].

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

a. [**IKG**]
b. [**Ohio Gratings, Inc**]
c. [**SlipNOT Metal Safety Flooring, division of Traction Technologies Holdings, LLC**]

2. Source Limitations: Obtain floor plate from single source from single manufacturer.

N. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

O. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

P. Zinc-Coated Steel Wire Rope: ASTM A741.

1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

Q. Stainless Steel Wire Rope: Wire rope manufactured from stainless steel wire complying with ASTM A492, Type 316.

1. Wire Rope Fittings: Stainless steel connectors, Type 316, with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

R. Steel Prestressing Strand: ASTM A416/A416M, Grade 270 (Grade 1860), low-relaxation, seven-wire, with 0.9-lb/sq. ft. (4.39-kg/sq. m) zinc coating.

1. Steel Prestressing Strand Fittings: Hot-dip galvanized-steel anchors and connectors with capability to sustain, without failure, a load equal to minimum breaking strength of steel prestressing strand with which they are used.

S. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: [**1-5/8 by 1-5/8 inches (41 by 41 mm)**][**As indicated**].
2. Galvanized Steel: ASTM A653/A653M, [**commercial steel, Type B**][**structural steel, Grade 33 (Grade 230)**], with **G90 (Z275)** coating; [**0.108-inch (2.8-mm)**][**0.079-inch (2-mm)**][**0.064-inch (1.6-mm)**] nominal thickness.
3. Cold-Rolled Steel: ASTM A1008/A1008M, [**commercial steel, Type B**][**structural steel, Grade 33 (Grade 230)**]; [**0.0966-inch (2.5-mm)**][**0.0677-inch (1.7-mm)**][**0.0528-inch (1.35-mm)**] minimum thickness; [**unfinished**][**coated with rust-inhibitive, baked-on, acrylic enamel**][**hot-dip galvanized after fabrication**].

T. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

U. Aluminum Plate and Sheet: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.

V. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.

W. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

X. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

Y. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

Z. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).

AA. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.

BB. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

A. General: Unless otherwise indicated, provide [**Type 304**][**Type 316**] stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening [**aluminum**][**stainless steel**][**or**][**nickel silver**].
2. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 3, heavy-hex steel structural bolts; **ASTM A563, Grade DH3, (ASTM A563M, Class 10S3)** heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, **ASTM F593 (ISO 3506-1)**; with hex nuts, **ASTM F594 (ASTM F836M)**; and, where indicated, flat washers; Alloy [**Group 1 (A1)**][**Group 2 (A4)**].

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

H. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ASTM F836M)**.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, **1-5/8 by 7/8 inches (41 by 22 mm)** by length indicated with anchor straps or studs not less than **3 inches (75 mm)** long at not more than **8 inches (200 mm)** o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of **3000 psi (20 MPa)**.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing[**and contour of welded surface matches that of adjacent surface**].

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, **1/8 by 1-1/2 inches (3.2 by 38 mm)**, with a minimum **6-inch (150-mm)** embedment and **2-inch (50-mm)** hook, not less than **8 inches (200 mm)** from ends and corners of units and **24 inches (600 mm)** o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated.

Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes [**indicated**][**recommended by partition manufacturer**] with attached bearing plates, anchors, and braces as [**indicated**][**recommended by partition manufacturer**]. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Provide bearing plates welded to beams where indicated.
2. Drill or punch girders and plates for field-bolted connections where indicated.
3. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at **24 inches (600 mm)** o.c.

E. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
2. Unless otherwise indicated, provide **1/2-inch (12.7-mm)** baseplates with four **5/8-inch (16-mm)** anchor bolts and **1/4-inch (6.4-mm)** top plates.

F. Galvanize miscellaneous framing and supports where indicated.

G. Prime miscellaneous framing and supports with [**zinc-rich primer**][**primer specified in Section 099600 "High-Performance Coatings"**] where indicated.

2.7 PREFABRICATED BUILDING COLUMNS

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

1. [**Black Rock Fireproof Column, a division of United Steel**]
2. [**Dean Lally LLC / FireTrol Columns**]

B. Source Limitations: Obtain prefabricated building column from single source from single manufacturer.

C. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.

D. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

1. Fire-Resistance Rating: [**4 hours**][**3 hours**][**2 hours**][**As indicated**].

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive **3/4-inch (19-mm)** bolts, spaced not more than **6 inches (150 mm)** from ends and **24 inches (600 mm)** o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately **2 inches (50 mm)** larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize[**and prime**] shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 METAL LADDERS

A. General:

1. Comply with ANSI A14.3[**, except for elevator pit ladders**].
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails [**16 inches (406 mm)**][**18 inches (457 mm)**] apart unless otherwise indicated.
2. Siderails: Continuous, [**3/8-by-2-1/2-inch (9.5-by-64-mm)**][**1/2-by-2-1/2-inch (12.7-by-64-mm)**] steel flat bars, with eased edges.
3. Rungs: [**3/4-inch- (19-mm-) diameter**][**3/4-inch- (19-mm-) square**][**1-inch- (25-mm-) diameter**][**1-inch- (25-mm-) square**], steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Nonslip Surfaces for Steel Ladders: Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.

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

        1) [**IKG**]
        2) [**SlipNOT Metal Safety Flooring, division of Traction Technologies Holdings, LLC**]

7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating,

supported by steel angles. Limit openings in gratings to no more than [1/2 inch (12 mm)][3/4 inch (19 mm)] in least dimension.

9. Support each ladder[**at top and bottom and not more than 60 inches (1500 mm) o.c.**] with welded or bolted steel brackets.
10. Galvanize[**and prime**][**exterior**]ladders, including brackets.
11. Prime [**exterior**]ladders, including brackets and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

C. Aluminum Ladders:

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

    a. [**Halliday Products**]
    b. [**Kattsafe**]
    c. [**O'Keeffe's Inc.**]
    d. [**Precision Ladders, LLC**]
    e. [**Royalite Manufacturing, Inc.**]
    f. [**Thompson Fabricating, LLC**]
    g. [**UPNOVR, Inc.**]

2. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.
3. Space siderails [16 inches (406 mm)][18 inches (457 mm)] apart unless otherwise indicated.
4. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
5. Rungs: Extruded-aluminum tubes, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, with ribbed tread surfaces.
6. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
7. Provide platforms as indicated fabricated from [**pressure-locked aluminum bar grating**][**or**][**extruded-aluminum plank grating**], supported by extruded-aluminum framing. Limit openings in gratings to no more than [1/2 inch (12 mm)][3/4 inch (19 mm)] in least dimension.
8. Support each ladder[**at top and bottom and not more than 60 inches (1500 mm) o.c.**] with welded or bolted aluminum brackets.
9. Provide minimum 72-inch- (1830-mm-) high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.10 ALTERNATING TREAD DEVICES

A. Alternating Tread Devices: Fabricate alternating tread devices of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

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

    a. [**Lapeyre Stair Inc.**]
    b. [**Precision Ladders, LLC**]

2. Tread depth is not to be less than **5 inches (127 mm)** exclusive of nosing or less than **8-1/2 inches (216 mm)**, including the nosing, tread width is not to be less than **7 inches (178 mm)**, and riser height is not to be more than **9-1/2 inches (241 mm)**.
3. Tread depth is not to be less than **8-1/2 inches (216 mm)** exclusive of nosing or less than **10-1/2 inches (267 mm)**, including the nosing, tread width is not to be less than **7 inches (178 mm)**, and riser height is not to be more than **8 inches (203 mm)**.
4. Fabricate from [**steel**][**stainless steel**][**aluminum**] and assemble by welding or with stainless steel fasteners.
5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."

B. Galvanize[**and prime**][**exterior**]steel alternating tread devices, including treads, railings, brackets, and fasteners.

C. Prime [**exterior**]steel alternating tread devices, including treads, railings, brackets, and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.11 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Provide metal [**ships' ladders**][**and**][**pipe crossovers**] where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Treads are not to be less than **5 inches (127 mm)** exclusive of nosing or less than **8-1/2 inches (216 mm)** including the nosing, and riser height is not to be more than **9-1/2 inches (241 mm)**.
2. Fabricate [**ships' ladders**][**and**][**pipe crossovers**], including railings from [**steel**][**stainless steel**][**aluminum**].
3. Fabricate treads[**and platforms**] from [**welded or pressure-locked steel bar**][**pressure-locked stainless steel bar**][**pressure-locked aluminum bar**][**extruded-aluminum plank**] grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**] in least dimension.
4. Fabricate treads[**and platforms**] from [**rolled-steel floor**][**rolled-stainless steel floor**][**rolled-aluminum-alloy tread**][**abrasive-surface floor**] plate.
5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."

B. Galvanize[**and prime**][**exterior**]steel [**ships' ladders**][**and**][**pipe crossovers**], including treads, railings, brackets, and fasteners.

C. Prime [**exterior**]steel [**ships' ladders**][**and**][**pipe crossovers**], including treads, railings, brackets, and fasteners, with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.12 METAL FLOOR PLATE

A. Fabricate from [**rolled-steel floor**][**rolled-stainless steel floor**][**rolled-aluminum-alloy tread**][**abrasive-surface floor**] plate of thickness indicated below:

1. Thickness: [**1/8 inch (3.2 mm)**][**3/16 inch (4.8 mm)**][**1/4 inch (6.4 mm)**][**5/16 inch (8 mm)**][**3/8 inch (9.5 mm)**][**As indicated**].

B. Provide grating sections where indicated, fabricated from [**welded or pressure-locked steel bar**][**pressure-locked stainless steel bar**][**pressure-locked aluminum bar**][**extruded-aluminum plank**] grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] in least dimension.

C. Provide [**steel**][**stainless steel**][**aluminum**] angle supports as indicated.

D. Include [**steel**][**stainless steel**][**aluminum**] angle stiffeners, and fixed and removable sections as indicated.

E. Provide flush [**steel**][**stainless steel**][**aluminum**] bar drop handles for lifting removable sections, one at each end of each section.

2.13 ELEVATOR PIT SUMP COVERS

A. Fabricate from [**1/8-inch (3.2-mm)**][**3/16-inch (4.8-mm)**][**rolled-steel**][**abrasive-surface**] floor plate with four **1-inch- (25-mm-)** diameter holes for water drainage and for lifting.

B. Fabricate from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than [**1/2 inch (12 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**] in least dimension.

C. Provide steel angle supports unless otherwise indicated.

2.14 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with **5/8-by-1-1/2-inch (16-by-38-mm)** steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than **10 inches (250 mm)** o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Galvanize[**and prime**][**exterior**]steel frames.

D. Prime [**exterior**]steel frames with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.15 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize[**and prime**][**exterior**]miscellaneous steel trim.

D. Prime [**exterior**]miscellaneous steel trim with [**zinc-rich primer.**][**primer specified in Section 099600**

"High-Performance Coatings."]

2.16 METAL BOLLARDS

A. Fabricate metal bollards from [**Schedule 80 steel pipe**][**Schedule 40 steel pipe**][**Schedule 80 stainless steel, No. 4/180-grit finish**][**1/4-inch (6.4-mm) wall-thickness rectangular steel tubing**][**steel shapes, as indicated**].

1. Cap bollards with **1/4-inch- (6.4-mm-)** thick, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] plate with [**flat**][**sloped**][**domed**] top.
2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Fabricate bollards with **3/8-inch- (9.5-mm-)** thick, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] baseplates for bolting to concrete slab. Drill baseplates at all four corners for **3/4-inch (19-mm)** anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Fabricate sleeves for bollard anchorage from steel or stainless steel [**pipe**][**or**][**tubing**] with **1/4-inch- (6.4-mm-)** thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than **8 inches (200 mm)** deep and **3/4 inch (19 mm)** larger than OD of bollard.

D. Fabricate internal sleeves for removable bollards from Schedule 80 [**steel**][**stainless steel**] pipe or **1/4-inch (6.4-mm)** wall-thickness [**steel**][**stainless steel**] tubing with an OD approximately **1/16 inch (1.5 mm)** less than ID of bollards. Match drill sleeve and bollard for **3/4-inch (19-mm)** [**steel**][**stainless steel**] machine bolt.

E. Prime steel bollards with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.17 VEHICULAR BARRIER CABLE SYSTEMS

A. Vehicular Barrier Cable Systems: Of diameter required by performance requirements, but not less than **1/2-inch- (12-mm-)** diameter, [**zinc-coated steel wire rope**][**stainless steel wire rope**][**zinc-coated steel prestressing strand**] with turnbuckles, toggles, machine swage terminals, and other fittings and accessories for securing to structural columns and walls and for tightening barrier cable.

2.18 PIPE AND DOWNSPOUT GUARDS

A. Fabricate [**pipe**][**downspout**] guards from **3/8-inch- (9.5-mm-)** thick by **12-inch- (300-mm-)** wide, [**steel**][**stainless steel, ASTM A480/A480M, No. 4 finish**] plate, bent to fit flat against the wall or column at both ends and to fit around pipe with **2-inch (50-mm)** clearance between pipe and pipe guard. Drill each end for two **3/4-inch (19-mm)** anchor bolts.

B. Galvanize[**and prime**] steel [**pipe**][**downspout**] guards.

C. Prime steel [**pipe**][**downspout**] guards with [**zinc-rich primer.**][**primer specified in Section 099600**

"High-Performance Coatings."]

2.19 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

A. Cast-Metal Units: Cast [**iron**][**aluminum**][**bronze (leaded red or semired brass)**][**nickel silver (leaded nickel bronze)**], with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

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

    a. [**American Safety Tread Co., Inc**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Barry Pattern & Foundry Co., Inc**]
    d. [**Safe-T-Metal Company, Inc.**]
    e. [**Wooster Products Inc**]

2. Source Limitations: Obtain units from single source from single manufacturer.
3. Cross-hatched nosings, **4 inches (100 mm)** wide, with **1/4-inch- (6-mm-)** thick **1-inch (25-mm)** lip, for casting into concrete.
4. Cross-hatched nosings, **1-1/2 inches (38-mm)** wide, **3/8-inch- (9.5-mm-)** thick **1-1/2 inch (38-mm)** lip, for casting into concrete.
5. Cross-hatched Treads: Full depth of tread with **3/4-by-3/4-inch (19-by-19-mm)** nosing, for application over bent plate treads or existing stairs.
6. Fluted-Saddle-Type Thresholds: **5 inches (125 mm)** wide by **1/2 inch (12 mm)** high, with tapered edges.
7. Fluted-Interlocking or -Hook-Strip Thresholds: **5 inches (125 mm)** wide by **5/8 inch (16 mm)** high, with tapered edge.
8. Thresholds: Plain-stepped- (stop-) type units, **5 inches (125 mm)** wide by **1/2 inch (12 mm)** high, with **1/2-inch (12-mm)** step.

B. Extruded Units: [**Aluminum**][**Bronze**], with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

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

    a. [**American Safety Tread Co., Inc**]
    b. [**Amstep Products**]
    c. [**Armstrong Products, Inc**]
    d. [**Balco; a CSW Industrials Company**]
    e. [**Nystrom, Inc.**]
    f. [**Wooster Products Inc**]

2. Source Limitations: Obtain units from single source from single manufacturer.
3. Provide ribbed units, with abrasive filler strips projecting **1/16 inch (1.5 mm)** above aluminum extrusion.
4. Provide solid-abrasive-type units without ribs.

5. Nosings:

   a. Square-back units, [1-7/8 inches (48 mm)][3 inches (75 mm)][4 inches (100 mm)] wide, for casting into concrete steps.
   b. Beveled-back units, [3 inches (75 mm)][4 inches (100 mm)] wide with 1-3/8-inch (35-mm) lip, for surface mounting on existing stairs.
   c. Two-piece units, 3 inches (75 mm) wide, with subchannel for casting into concrete steps.

6. Treads: [**Square**][**Beveled**]-back units, full depth of tread with 1-3/8-inch (35-mm) lip, for application over existing stairs.

C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

D. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.

1. Provide two rows of holes for units more than 5 inches (125 mm) wide, with two holes aligned at ends and intermediate holes staggered.

E. Apply bituminous paint to concealed surfaces of cast-metal units.

F. Apply clear lacquer to concealed surfaces of extruded units.

2.20 CAST-IRON WHEEL GUARDS

A. Provide wheel guards made from cast-iron, 3/4-inch- (19-mm-) thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.

B. Prime cast-iron wheel guards with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.21 METAL DOWNSPOUT BOOTS

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

1. [**J.R. Hoe & Sons Inc.**]
2. [**Neenah Foundry Company**]

B. Source Limitations: Obtain downspout boots from single source from single manufacturer.

C. Provide downspout boots made from cast [**iron**][**aluminum**] in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.

1. Outlet: [**Vertical, to discharge into pipe**][**Horizontal, to discharge into pipe**][**At 35 degrees from horizontal, to discharge onto splash block or pavement**].

D. Prime cast-iron downspout boots with [**zinc-rich primer.**][**primer specified in Section 099600 "High-**

Performance Coatings."]

2.22 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize bearing and leveling plates.

C. Prime plates with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.23 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than **8 inches (200 mm)** unless otherwise indicated.

C. Galvanize[**and prime**] loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with [**zinc-rich primer.**][**primer specified in Section 099600 "High-Performance Coatings."**]

2.24 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.25 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.26 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items[**not indicated to be galvanized**] unless they are to be embedded in

concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting"**][**primers specified in Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 3, "Power Tool Cleaning."**][**requirements indicated below:**]

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.27 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for [**ceiling-hung toilet partitions**][**operable partitions**][**overhead doors**][**and**][**overhead grilles**] securely to, and rigidly brace from, building structure.

C. Anchor shelf angles securely to existing construction with [**expansion anchors**][**anchor bolts**][**through bolts**].

D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

E. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.

3.4 INSTALLATION OF SHELF ANGLES

A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

3.5 INSTALLATION OF METAL LADDERS

A. Secure ladders to adjacent construction with the clip angles attached to the stringer.

B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.6 INSTALLATION OF ALTERNATING TREAD DEVICES

A. Secure top and bottom of alternating tread devices to construction to comply with manufacturer's written instructions.

3.7 INSTALLATION OF METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Secure top and bottom of ships' ladders to construction to comply with manufacturer's written instructions.

B. Secure pipe crossovers to construction to comply with manufacturer's written instructions.

3.8 INSTALLATION OF METAL FLOOR PLATE

A. Install metal floor plates flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.9 INSTALLATION OF ELEVATOR PIT SUMP COVERS

A. Install tops of elevator sump pit cover plates and frames flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.10 INSTALLATION OF STRUCTURAL-STEEL DOOR FRAMES

A. Fasten structural steel door frames to the floor slab by means of angle clips and expansion bolts. Anchor door jambs to adjacent construction in accordance with shop drawing details.

3.11 INSTALLATION OF MISCELLANEOUS STEEL TRIM

A. Anchor to concrete construction to comply with manufacturer's written instructions.

3.12 INSTALLATION OF METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

1. Do not fill removable bollards with concrete.

B. Anchor bollards to existing construction with [**expansion anchors**][**anchor bolts**][**through bolts**]. Provide four **3/4-inch (19-mm)** bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least **4 inches (100 mm)** in concrete.

C. Anchor bollards in concrete [**with pipe sleeves preset and anchored into concrete**][**in formed or core-drilled holes not less than 42 inches (1050 mm) deep and 3/4 inch (19 mm) larger than OD of bollard**]. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward bollard.

D. Anchor bollards in place with concrete footings. Center and align bollards in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

E. Anchor internal sleeves for removable bollards in [**concrete by inserting in pipe sleeves preset into concrete**][**formed or core-drilled holes not less than 42 inches (1050 mm) deep and 3/4 inch (19 mm) larger than OD of sleeve**]. Fill annular space around internal sleeves solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward internal sleeve.

F. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.

G. Place removable bollards over internal sleeves and secure with **3/4-inch (19-mm)** machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. The Owner furnishes padlocks.

H. Fill bollards solidly with concrete, mounding top surface to shed water.

1. Do not fill removable bollards with concrete.

3.13 INSTALLATION OF VEHICULAR BARRIER CABLE SYSTEMS

A. Install vehicular barrier cable systems at locations indicated, mounted at heights indicated on Drawings above the parking surface. Anchor [**wire ropes**][**steel prestressing strand**] to structural columns and walls and tension to withstand vehicle loading as specified in "Performance Requirements" Article with no cable tensioned less than **3000 lbf (13.3 kN)**. Do not displace supporting components.

3.14 INSTALLATION OF PIPE AND DOWNSPOUT GUARDS

A. Provide pipe guards at exposed vertical pipes in [**parking garage**][**at locations indicated on Drawings**] where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four **3/4-inch (19-mm)** bolts at each pipe guard. Mount pipe guards with top edge **26 inches (660 mm)** above driving surface.

3.15 INSTALLATION OF ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.16 INSTALLATION OF CAST-IRON WHEEL GUARDS

A. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

3.17 INSTALLATION OF METAL DOWNSPOUT BOOTS

A. Anchor metal downspout boots to concrete or masonry construction to comply with manufacturer's written instructions.

B. Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.

3.18 INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.19 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

   a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**]

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 05 19 00

Task	Specification	Specification Description
05 05 21 00	05 12 00 00	Structural Steel Framing
05 05 23 00	01 22 00 00	No Specification Required
05 05 23 00	05 12 00 00	Structural Steel Framing
05 05 23 00	05 05 19 00	Metal Fabrications

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SECTION 05 12 00 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Bolts and connectors.
3. Rods.
4. Forged-steel structural hardware.
5. Slide bearings.
6. Shrinkage-resistant grout.
7. Prefabricated building columns.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.
4. [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"**][**and**][**Section 099600 "High-Performance Coatings"**] for painting requirements.
5. [**Section 099114 "Exterior Painting (MPI Standards)" and Section 099124 "Interior Painting (MPI Standards)"**][**and**][**Section 099601 "High-Performance Coatings (MPI Standards)"**] for painting requirements.
6. Section 133419 "Metal Building Systems" for structural steel.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A6/A6M with flanges thicker than **1-1/2 inches (38 mm)**.
2. Welded built-up members with plates thicker than **2 inches (50 mm)**.
3. Column base plates thicker than **2 inches (50 mm)**.

D. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint [**whether prequalified or qualified by testing**][**qualified by testing**] , including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated Design Submittals: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data [**signed and sealed by the qualified professional engineer responsible for their preparation**] .

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Health Product Declaration (HPD): For each product.

12. Health Product Declaration (HPD): Provide HPD.

13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

14. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

15. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

16. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

17. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

18. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List Approved. Submittal must contain inventory assessment completed to at least 0.01 percent

(100 ppm) and certification expiration date.

19. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.6 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For specified shop and field welding.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Mill Test Reports: For structural-steel materials, including chemical and physical properties.

D. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.

E. Source Quality Control Reports: For structural-steel framing.

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

G. Qualification Statements: For [**Installer**][**fabricator**][**shop-painting applicators**][**professional engineer**][**testing agency**] .

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, [**Category ACSE**][**Category CSE**] .

C. Shop-Painting Applicator Qualifications: Qualified in accordance with AISC's Sophisticated Paint [**Endorsement P1**][**Endorsement P2**][**Endorsement P3**] or to SSPC-QP 3.

D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided the Owner’s testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.

2. ANSI/AISC 341.
3. ANSI/AISC 360.
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

2. Option 2: Fabricator's experienced steel detailer selects or completes connections in accordance with ANSI/AISC 303.

a. Select and complete connections using [**schematic details indicated**][**and**][**ANSI/AISC 360**] .
b. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

3. Option 3 and 3A: Design connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer. Member reinforcement at connections is indicated on Drawings.

a. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

4. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

a. Use [**Load and Resistance Factor Design; data are given at factored-load level**][**Allowable Stress Design; data are given at service-load level**] .

C. Moment Connections: [**Type PR, partially**][**Type FR, fully**] restrained.

D. Construction: [**Moment frame**][**Braced frame**][**Shear wall system**][**Combined system of moment frame and braced frame**][**Combined system of moment frame and shear walls**][**Combined system of braced frame and shear walls**][**Combined system of moment frame, braced frame, and shear**

walls] .

2.2 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. W-Shapes: [**ASTM A992/A992M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

C. Channels, Angles, M-Shapes: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

D. Channels, Angles, S-Shapes: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**][**ASTM A913/A913M, Grade 50 (Grade 345)**] .

E. Plate and Bar: [**ASTM A36/A36M**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A529/A529M, Grade 50 (Grade 345)**] .

F. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, **50 ksi (345 MPa)**.

G. Cold-Formed Hollow Structural Sections: [**ASTM A500/A500M, Grade B**][**ASTM A500/A500M, Grade C**][**ASTM A1085/ASTMA1085M**] structural tubing.

H. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847/A847M structural tubing.

I. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

1. Weight Class: [**Standard**][**Extra strong**][**Double-extra strong**] .
2. Finish: [**Black**][**Galvanized**][**Black except where indicated to be galvanized**] .

J. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.

K. Steel Forgings: ASTM A668/A668M.

L. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1 (Type 8.8-1)**, compressible-washer type with plain finish.

B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A490 (Grade A490M)**, Type 1, heavy-hex steel structural bolts [**or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends**] ; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex

carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, **Type 490-1 (Type 10.9-1)**, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Hot-dip zinc coating**][**Mechanically deposited zinc coating**][**Hot-dip or mechanically deposited zinc coating**] .
2. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1 (Type 8.8-1)**, compressible-washer type with [**mechanically deposited zinc coating**][**mechanically deposited zinc coating, baked epoxy-coated**] finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, [**heavy-hex**][**round**] head assemblies, consisting of steel structural bolts with splined ends; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Plain**][**Mechanically deposited zinc coating**] .

E. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

A. Unheaded Anchor Rods: [**ASTM F1554, Grade 36**][**ASTM F1554, Grade 55, weldable**][**ASTM A354**][**ASTM A449**][**ASTM A572/A572M, Grade 50 (Grade 345)**][**ASTM A36/A36M**] .

1. Configuration: [**Straight**][**Hooked**] .
2. Nuts: **ASTM A563 (ASTM A563M)** [**heavy-**] hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: **ASTM F436 (ASTM F436M)**, Type 1, hardened carbon steel.
5. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

B. Headed Anchor Rods: [**ASTM F1554, Grade 36**][**ASTM F1554, Grade 55, weldable**][**ASTM A354**][**ASTM A449**] , straight.

1. Nuts: **ASTM A563 (ASTM A563M)** [**heavy-**] hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.
3. Washers: **ASTM F436 (ASTM F436M)**, Type 1, hardened carbon steel.
4. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

C. Threaded Rods: [**ASTM A36/A36M**][**ASTM A193/A193M, Grade B7**][**ASTM A354, Grade BD**][**ASTM A449**][**ASTM A572/A572M, Grade 50 (Grade 345)**] .

1. Nuts: **ASTM A63 (ASTM A563M)** [**heavy-**] hex carbon steel.
2. Washers: [**ASTM F436 (ASTM F436M), Type 1, hardened**][**ASTM A36/A36M**] carbon steel.
3. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**] .

2.5 FORGED-STEEL STRUCTURAL HARDWARE

A. Clevises and Turnbuckles: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1035.

B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.

C. Sleeve Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1018.

2.6 SLIDE BEARINGS

A. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.

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

a. [**Amscot Structural Products Corp.**]
b. [**Fluorocarbon Company Limited**]
c. [**GRM Custom Products**]
d. [**R.J. Watson Bridge & Structural Engineered Systems**]

2. Mating Surfaces: [**PTFE and PTFE**][**PTFE and mirror-finished stainless steel**] .
3. Coefficient of Friction: Not more than [**0.03**][**0.04**][**0.05**][**0.06**][**0.10**][**0.12**] .
4. Design Load: Not less than [**2000 psi (13.7 MPa)**][**5000 psi (34 MPa)**][**6000 psi (41 MPa)**] .

5. Total Movement Capability: [**2 inches (50 mm)**] .

2.7 PRIMER

A. Steel Primer:

1. Comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**][**Section 099114 "Exterior Painting (MPI Standards)" and Section 099124 "Interior Painting (MPI Standards)."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**][**Section 099114 "Exterior Painting (MPI Standards)," Section 099124 "Interior Painting (MPI Standards)," and Section 099601 "High-Performance Coatings (MPI Standards)."**]

2. SSPC-Paint 23, latex primer.

3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer: [**MPI#26**][**MPI#80**][**MPI#134**] .

1. Etching Cleaner: MPI#25, for galvanized steel.

2. Galvanizing Repair Paint: [**MPI#18, MPI#19, or SSPC-Paint 20**][**ASTM A780/A780M**] .

2.8 SHRINKAGE-RESISTANT GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.9 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, [**mechanically thermal cut,**] or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with [**SSPC-SP 1**][**SSPC-SP 2**][**SSPC-SP 3**] .

F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded-Steel Door Frames: Build up welded-steel doorframes attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than **10 inches (250 mm)** o.c. unless otherwise indicated on Drawings.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. [**Do not thermally cut bolt holes or enlarge holes by burning.**]
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.10 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: [**Snug tightened**][**Pretensioned**][**Slip critical**] .

B. Weld Connections: Comply with AWS D1.1/D1.1M [**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.11 PREFABRICATED BUILDING COLUMNS

A. Prefabricated Building Column : Consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.

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

a. [**Black Rock Fireproof Column, a division of United Steel**]
b. [**Dean Lally LLC / FireTrol Columns**]

2. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

a. Fire-Resistance Rating: [**Four hours**][**Three hours**][**Two hours**][**As indicated on Drawings**] .

2.12 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize [**lintels**][**shelf angles**][**and**][**welded door frames**] attached to structural-steel frame and located in exterior walls.

2.13 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of **2 inches (50 mm)**.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces [**unless indicated to be painted**] .
6. Corrosion-resisting (weathering) steel surfaces.
7. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7 (WAB)/NACE WAB-4.
4. SSPC-SP 14 (WAB)/NACE WAB-8.
5. SSPC-SP 11.
6. SSPC-SP 6 (WAB)/NACE WAB-3.
7. SSPC-SP 10 (WAB)/NACE WAB-2.
8. SSPC-SP 5 (WAB)/NACE WAB-1.
9. SSPC-SP 8.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner [**or in accordance with SSPC-SP 16**] .

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of **1.5 mils (0.038 mm)**. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.14 SOURCE QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

2. Bolted Connections: Inspect [**and test**] shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E165/E165M.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94/E94M.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.

    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.

5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

    1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

    1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION OF STRUCTURAL-STEEL FRAMING

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Rods: [**Snug-tighten**][**Pretension**] anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Shrinkage-Resistant Grout: Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. [**Comply with manufacturer's written installation instructions for grouting.**]

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection [**unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M**], as directed by the Owner.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: [**Snug tightened**][**Pretensioned**][**Slip critical**] .

B. Weld Connections: Comply with AWS D1.1/D1.1M [**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs [**where indicated**] , back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.5 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 REPAIR

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting:

1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Cleaning and touchup painting are specified in [**Section 099113 "Exterior Painting."**][**Section 099114 "Exterior Painting (MPI Standards)."**][**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**][**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

C. Touchup Priming: Cleaning and touchup priming are specified in [**Section 099600 "High-Performance Coatings."**][**Section 099601 "High-Performance Coatings (MPI Standards)."**]

3.7 FIELD QUALITY CONTROL

A. Special Inspections: the Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect [**and test**] bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

    a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

        1) Liquid Penetrant Inspection: ASTM E165/E165M.
        2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
        3) Ultrasonic Inspection: ASTM E164.
        4) Radiographic Inspection: ASTM E94/E94M.

3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

    b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 05 12 00 00

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Task	Specification	Specification Description
05 12 23 00	05 12 00 00	Structural Steel Framing
05 12 23 00	05 40 00 00	Cold-Formed Metal Framing
05 12 23 00	05 05 19 00	Metal Fabrications
05 13 00 00	05 12 00 00	Structural Steel Framing
05 13 00 00	05 05 19 00	Metal Fabrications
05 14 13 00	01 22 00 00	No Specification Required
05 15 16 00	05 05 19 00	Metal Fabrications
05 15 16 00	05 70 00 00	Decorative Metal
05 15 19 00	05 70 00 00	Decorative Metal

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SECTION 05 21 00 00 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel joists and joist girders.
2. Primers.
3. Steel joist accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.2 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Mill Certificates: For each type of bolt.

D. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

E. Field quality control reports.

F. Qualification Statements: For [**manufacturer**] [**Erector**] [**testing agency**].

G. Delegated Design Engineer Qualifications: For steel joist framing.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**]

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Erector Qualifications: An experienced Erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

D. Welding Qualifications: Qualify field-welding procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**]

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.7 SEQUENCING

A. Deliver steel bearing plates to be built into [**cast-in-place concrete**] [**and**] [**masonry**] construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design steel joist framing.

B. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.

1. Use [**ASD; data are given at service-load level**] [**LRFD; data are given at factored-load level**].
2. Design special joists to withstand design loads with live-load deflections no greater than the following:

    a. Floor Joists: Vertical deflection of [**1/360**] [**1/240**] of the span.
    b. Roof Joists: Vertical deflection of [**1/360**] [**1/240**] of the span.

2.2 STEEL JOISTS AND JOIST GIRDERS

A. K-Series Steel Joist: Manufactured steel joists of type indicated in accordance with "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: [**K-series steel joists**] [**and**] [**KCS-type K-series steel joists**].
2. K-Series Steel Joist Substitutes: Manufactured in accordance with "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
3. Provide holes in chord members for connecting and securing other construction to joists.
4. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
5. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends as indicated on Drawings, complying with SJI's "Specifications."
6. Do not camber joists.
7. Camber joists [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**]
8. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

B. Long-Span Steel Joist: Manufactured in accordance with "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements[**as follows:**][**as indicated on Drawings.**]

1. Joist Type: [**LH-series long-span steel joists**] [**and**] [**DLH-series long-span steel joists**].
2. End Arrangement: [**Underslung**] [**Square**].
3. Top-Chord Arrangement: [**Parallel**] [**Pitched 1/8 inch per 12 inches (1:96), one way**] [**Pitched 1/8 inch per 12 inches (1:96), two ways**].
4. Provide holes in chord members for connecting and securing other construction to joists.
5. Camber long-span steel joists [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**].
6. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

C. Composite Steel Joist: Manufactured in accordance with "Standard Specifications for Composite Steel Joists, CJ-Series" in SJI's "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice," with steel-angle top- and bottom-chord members and parallel top chord, and with [**underslung**] [**square**] ends.

1. Camber composite steel joists [**as indicated on Drawings**]

D. Joist Girders: Manufactured in accordance with "Standard Specification for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements[**as follows:**][**as indicated on Drawings.**]

1. End Arrangement: [**Underslung**] [**Underslung with bottom-chord extensions**] [**Square**].

2. Top-Chord Arrangement: [**Parallel**] [**Pitched 1/8 inch per 12 inches (1:96), one way**] [**Pitched 1/8 inch per 12 inches (1:96), two ways**].
3. Provide holes in chord members for connecting and securing other construction to joist girders.
4. Camber joist girders [**in accordance with SJI's "Specifications."**] [**as indicated on Drawings.**].
5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.3 PRIMERS

A. Primer:

1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
2. Provide shop primer that complies with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

2.4 STEEL JOIST ACCESSORIES

A. Bridging:

1. Provide bridging anchors and number of rows of [**horizontal**] [**or**] [**diagonal**] bridging of material, size, and type required by SJI's "Specifications"[**and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice"**] for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
2. Detail and fabricate in accordance with SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**] Furnish additional erection bridging if required for stability.
3. Fabricate as indicated on Drawings and in accordance with SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**] Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings. [**Shop prime paint**] [**Hot-dip zinc coat in accordance with ASTM A123/A123M**].

C. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."

D. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.

1. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated on Drawings.
2. Finish: [**Plain, uncoated**] [**Hot-dip zinc coating, ASTM A153/A153M, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

E. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563/A563M, Grade DH (Grade 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Plain**] [**Hot-dip zinc coating, ASTM A153/A153M, Class C**] [**Mechanically deposited zinc coating, ASTM B695, Class 50**].

F. Welding Electrodes: Comply with AWS standards.

G. Galvanizing Repair Paint: [**MPI#18, MPI#19, or SSPC-Paint 20**] [**ASTM A780/A780M**].

H. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by [**hand-tool cleaning, SSPC-SP 2**] [**or**] [**power-tool cleaning, SSPC-SP 3**].

B. Do not prime paint joists and accessories[**to receive sprayed fire-resistive materials**].

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.

D. Shop priming of joists and joist accessories is specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION OF STEEL JOISTS AND JOIST GIRDERS

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction in accordance with SJI's "Specifications[**,"**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice,"**] joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel [**bearing plates**] [**and**] [**framework**]. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting:

1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists[**, bearing plates,**] [**abutting structural steel,**] and accessories.

   a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
   b. Apply a compatible primer of same type as primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds in accordance with AWS D1.1/D1.1M.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports.

END OF SECTION 05 21 00 00

Task	Specification	Specification Description
05 21 19 00	05 21 00 00	Steel Joist Framing

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SECTION 05 31 13 00 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.
2. Acoustical roof deck.
3. Composite floor deck.
4. Electrified cellular floor deck.
5. Noncomposite form deck.
6. Noncomposite vented form deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck.
3. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
4. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.
2. Acoustical roof deck.
3. Composite floor deck.
4. Electrified cellular floor deck.
5. Noncomposite form deck.
6. Noncomposite vented form deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Health Product Declaration (HPD): For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Test and Evaluation Reports:

1. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

a. Power-actuated mechanical fasteners.
b. Acoustical roof deck.

2. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

E. Qualification Statements: For [**welding personnel**][**and**][**testing agency**].

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

B. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.

C. FM Approvals' RoofNav Listing: Provide steel roof deck evaluated by FM Approvals and listed in its "RoofNav" for Class 1 fire rating and [**Class 1-60**][**Class 1-75**][**Class 1-90**] windstorm ratings. Identify materials with FM Approvals Certification markings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.2 ROOF DECK

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

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Epic Metals Corporation**]
7. [**Marlyn Steel Decks, Inc.**]
8. [**Miami Metal Deck**]
9. [**New Millennium Building Systems, LLC**]
10. [**OEG Building Materials Inc**]
11. [**Roof Deck, Inc**]
12. [**Tristate Decking, Inc.**]
13. [**Valley Joist**]
14. [**Verco Decking, Inc.; a Nucor company**]
15. [**Vulcraft Group; Division of Nucor Corp.**]
16. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

4. Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792/A792M, Structural Steel (SS), Grade **33 (230)** minimum, **AZ50 (AZ150)** aluminum-zinc-alloy coating.
5. Deck Profile: [**As indicated**][**Type NR, narrow rib**][**Type IR, intermediate rib**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**].
6. Cellular Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**], with bottom plate.
7. Profile Depth: [**As indicated**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**7-1/2 inches (190 mm)**].
8. Design Uncoated-Steel Thickness: [**As indicated**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**][**0.0747 inch (1.90 mm)**].
9. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**As indicated**][**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0474/0.0474 inch (1.20/1.20 mm)**][**0.0474/0.0598 inch (1.20/1.52 mm)**][**0.0598/0.0474 inch (1.52/1.20 mm)**][**0.0598/0.0598 inch (1.52/1.52 mm)**].
10. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
11. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].

2.3 ACOUSTICAL ROOF DECK

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

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**DACS, Inc.**]
5. [**Epic Metals Corporation**]
6. [**Marlyn Steel Decks, Inc.**]
7. [**Miami Metal Deck**]
8. [**Roof Deck, Inc**]
9. [**Vulcraft Group; Division of Nucor Corp.**]

B. Fabrication of Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, shop primed with manufacturer's standard baked-on, rust-

inhibitive primer.

a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

4. Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792/A792M, Structural Steel (SS), Grade **33 (230)** minimum, **AZ50 (AZ150)** aluminum-zinc-alloy coating.
5. Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**].
6. Cellular Deck Profile: [**As indicated**][**Type WR, wide rib**][**Type 3DR, deep rib**][**Long span**], with bottom plate.
7. Profile Depth: [**As indicated**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (76 mm)**][**4-1/2 inches (114 mm)**][**6 inches (152 mm)**][**7-1/2 inches (190 mm)**].
8. Design Uncoated-Steel Thickness: [**As indicated**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
9. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**As indicated**][**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0474/0.0358 inch (1.20/0.91 mm)**][**0.0474/0.0474 inch (1.20/1.20 mm)**][**0.0474/0.0598 inch (1.20/1.52 mm)**][**0.0598/0.0474 inch (1.52/1.20 mm)**][**0.0598/0.0598 inch (1.52/1.52 mm)**].
10. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
11. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].
12. Acoustical Perforations: [**Deck units with manufacturer's standard perforated vertical webs**][**Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck**].
13. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.

a. Factory install sound-absorbing insulation into cells of cellular deck.

14. Acoustical Performance: NRC [**0.65**][**0.75**][**0.80**][**0.85**][**0.90**], tested in accordance with ASTM C423.

2.4 COMPOSITE FLOOR DECK

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

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Epic Metals Corporation**]
7. [**Marlyn Steel Decks, Inc.**]
8. [**Miami Metal Deck**]
9. [**New Millennium Building Systems, LLC**]
10. [**OEG Building Materials Inc**]

11. [**Roof Deck, Inc**]
12. [**Tristate Decking, Inc.**]
13. [**Verco Decking, Inc.; a Nucor company**]
14. [**Vulcraft Group; Division of Nucor Corp.**]
15. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with SDI C, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard [**gray**][**or**][**white**] baked-on, rust-inhibitive primer.
2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G30 (Z90)**][**G60 (Z180)**] zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.
4. Profile Depth: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**As indicated**].
5. Design Uncoated-Steel Thickness: [**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
6. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].

2.5 ELECTRIFIED CELLULAR FLOOR DECK

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

1. [**Cordeck**]
2. [**HH Robertson**]

B. Source Limitations for Electrified Cellular Floor Deck: Obtain cellular floor-deck units and compatible electrical components, such as preset inserts, activation kits, afterset inserts, service fittings, header ducts, and trench header ducts, from single manufacturer.

C. Fabrication of Electrified Cellular Floor Deck: Fabricate steel sheet cellular floor-deck panels, consisting of a ribbed top section welded to a lower flat-bottom sheet with interlocking side laps, to comply with SDI C. Fabricate deck to the minimum section properties, width of panel, number, and area of cells per panel indicated.

1. Cellular Deck Type: [**Composite**][**Noncomposite**].
2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, **G60 (Z180)** zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.
4. Profile Depth: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**As indicated**].
5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: [**0.0358/0.0358 inch (0.91/0.91 mm)**][**0.0358/0.0474 inch (0.91/1.20 mm)**][**0.0358/0.0598 inch (0.91/1.52 mm)**][**0.0474/0.0358**

inch (1.20/0.91 mm)][0.0474/0.0474 inch (1.20/1.20 mm)][0.0474/0.0598 inch (1.20/1.52 mm)][0.0598/0.0474 inch (1.52/1.20 mm)][0.0598/0.0598 inch (1.52/1.52 mm)].

6. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
7. Factory punch holes, of size and arrangement indicated, into each deck cell at preset inserts and header duct locations.

2.6 NONCOMPOSITE FORM DECK

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

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Cordeck**]
4. [**CSM Metal Deck**]
5. [**DACS, Inc.**]
6. [**Marlyn Steel Decks, Inc.**]
7. [**Miami Metal Deck**]
8. [**New Millennium Building Systems, LLC**]
9. [**OEG Building Materials Inc**]
10. [**Roof Deck, Inc**]
11. [**Valley Joist**]
12. [**Verco Decking, Inc.; a Nucor company**]
13. [**Vulcraft Group; Division of Nucor Corp.**]
14. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Noncomposite Form Deck: Fabricate ribbed-steel sheet noncomposite deck panels used as a form to comply with SDI NC, with the minimum section properties indicated, and with the following:

1. Uncoated Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum.
2. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**] minimum, with[**top and**] underside surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

3. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
4. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 80 (550)**], **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

5. Profile Depth: [**9/16 inch (14 mm)**][**15/16 inch (24 mm)**][**1-5/16 inches (33 mm)**][**1-1/2 inches (38 mm)**].
6. Design Uncoated-Steel Thickness: [**0.0149 inch (0.38 mm)**][**0.0179 inch (0.45 mm)**][**0.0239 inch (0.61 mm)**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
7. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
8. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].

2.7 NONCOMPOSITE VENTED FORM DECK

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

1. [**ASC Steel Deck; ASC Profiles, LLC**]
2. [**Canam Buildings US Inc.; Canam Group Inc.**]
3. [**Marlyn Steel Decks, Inc.**]
4. [**Miami Metal Deck**]
5. [**New Millennium Building Systems, LLC**]
6. [**Roof Deck, Inc**]
7. [**Verco Decking, Inc.; a Nucor company**]
8. [**Vulcraft Group; Division of Nucor Corp.**]
9. [**Vulcraft/Verco Group; a division of Nucor Corp.**]

B. Fabrication of Noncomposite Vented Form Deck: Fabricate ribbed- and vented-steel sheet noncomposite deck panels used as a form to comply with SDI NC, and with the following:

1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 40 (275)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**][**G90 (Z275)**] zinc coating.
2. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), [**Grade 33 (230)**][**Grade 80 (550)**], [**G30 (Z90)**][**G60 (Z180)**] zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: [**Manufacturer's standard**][**Gray**][**White**][**Gray top surface with white underside**].

3. Profile Depth: [**9/16 inch (14 mm)**][**15/16 inch (24 mm)**][**1-5/16 inches (33 mm)**][**1-1/2 inches (38 mm)**].
4. Design Uncoated-Steel Thickness: [**0.0149 inch (0.38 mm)**][**0.0179 inch (0.45 mm)**][**0.0239 inch (0.61 mm)**][**0.0295 inch (0.75 mm)**][**0.0358 inch (0.91 mm)**][**0.0474 inch (1.20 mm)**][**0.0598 inch (1.52 mm)**].
5. Span Condition: [**As indicated**][**Simple span**][**Double span**][**Triple span or more**].
6. Side Laps: [**Overlapped**][**Interlocking seam**][**Overlapped or interlocking seam at Contractor's option**].
7. Vent Slot Area: Manufacturer's standard vent slots providing [**1-1/2**] percent open area.

2.8 ACCESSORIES

A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, **No. 10 (4.8-mm)** minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, not less than **0.0359-inch (0.91-mm)** design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, of same material and finish as deck, and of thickness and profile [**indicated**][**recommended by SDI standards for overhang and slab depth**].

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, [**0.0598 inch (1.52 mm)**][**0.0747 inch (1.90 mm)**] thick, with factory-punched hole of **3/8-inch (9.5-mm)** minimum diameter.

J. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

K. Flat Sump Plates: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck. For drains, cut holes in the field.

L. Recessed Sump Pans: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck, with **3-inch- (76-mm-)** wide flanges and [**level**][**sloped**] recessed pans of **1-1/2-inch (38-mm)** minimum depth. For drains, cut holes in the field.

M. Galvanizing Repair Paint: [**ASTM A780/A780M**][**SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight**].

N. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

J. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than **1-1/2 inches (38 mm)** long, and as follows:

1. Weld Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**], nominal.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds [**18 inches (460 mm) apart, maximum**][**12 inches (300 mm) apart in Zone 1 and 6 inches (150 mm) apart in Zones 2 and 3, based on roof-area definitions in FM Global Loss Prevention Data Sheet 1-28**][**as indicated**].
3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or [**18 inches (460 mm)**][**36 inches (1 m)**], and as follows:

1. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches (38 mm)**, with end joints as follows:

1. End Joints: [**Lapped 2 inches (50 mm) minimum**][**Butted**][**Lapped 2 inches (50 mm) minimum or butted at Contractor's option**].

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and [**weld**][**mechanically fasten**] flanges to top of deck. Space [**welds**][**mechanical fasteners**] not more than **12 inches (300 mm)** apart with at least one [**weld**][**fastener**] at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and [**weld**][**or**][**mechanically fasten**].

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions.
[**Weld**][**or**][**mechanically fasten**] to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 INSTALLATION OF FLOOR DECK

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**], nominal.
2. Weld Spacing:
   a. Weld edge ribs of panels at each support. Space additional welds an average of **16 inches (400 mm)** apart, but not more than **18 inches (460 mm)** apart.
   b. Space and locate welds as indicated.
3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or **36 inches (1 m)**, and as follows:

1. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of [**1-1/2 inches (38 mm)**], with end joints as follows:

1. End Joints: [**Lapped**][**Butted**][**Lapped or butted at Contractor's option**].

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Electrified Cellular Floor Deck: Install cellular floor system with deck assembled from [**all-cellular units**][**alternating cellular units with noncellular composite units**][**units indicated**].

1. Coordinate layout and installation of trench headers, preset inserts, duct fittings, and other components specified in Section 260539 "Underfloor Raceways for Electrical Systems" with installation of electrified cellular metal floor deck.

G. Install piercing hanger tabs at [**14 inches (355 mm)**] apart in both directions, within **9 inches (228 mm)** of walls at ends, and not more than **12 inches (305 mm)** from walls at sides unless otherwise indicated.

3.5 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on [**both surfaces**][**top surface**] of prime-painted deck immediately after installation, and apply repair paint.
2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.

    a. Field welds will be subject to inspection.

2. Steel decking will be considered defective if it does not pass tests and inspections.
3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors that are already tested.

C. Prepare test and inspection reports.

END OF SECTION 05 31 13 00

Task	Specification	Specification Description
05 31 33 00	05 31 13 00	Steel Decking
05 36 00 00	05 31 13 00	Steel Decking

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SECTION 05 40 00 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-formed steel framing.
2. Load-bearing wall framing.
3. Exterior non-load-bearing wall framing.
4. Vertical deflection clips, exterior.
5. Interior non-load-bearing wall framing.
6. Vertical deflection clips, interior.
7. Floor joist framing.
8. Roof-rafter framing.
9. Soffit framing.
10. Sill sealer gasket/termite barrier.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, within height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
3. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For cold-formed steel framing, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Environmental Product Declaration (EPD): For each product.

5. Health Product Declaration (HPD): For each product.

6. Environmental Product Declaration (EPD): For each product.

7. Environmental Product Declaration (EPD): For each product.

8. Environmental Product Declaration (EPD): For each product.
9. Third-Party Certifications: For each product.
10. Third-Party-Certified Life-Cycle Assessment: For each product.

11. Product Data for Embodied Carbon Emissions: Indicating embodied carbon emissions, defined as GWP/unit times material amount used in Project.

12. Product Data for Cradle-to-Cradle Certification:

    a. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Bronze level. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration.

    b. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Silver level or Material Health Silver Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

    c. Confirming Cradle-to-Cradle certification under Version 3.1, 4, or 4.1 at Gold level or Material Health Gold Certificate. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration.

13. Product Data for Health Product Declaration Compliance:

    a. Prechecked for LEED HPD with full ingredient inventory to at least 0.1 percent (1000 ppm) and proof of publication in HPD Repository Standard.

    b. HPD prechecked for LEED v4.1, Option 2, confirming that either no GreenScreen LT-1 hazards or no GHS Category 1 hazards are present in installed product. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and HPD expiration.

14. Product Data for Declare Certification:

    a. Confirming Declare certification under Version 2. Submittal must contain inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

    b. Confirming Declare certification Third-Party Verified and Red List Free or Red List

Approved. Submittal must contain inventory assessment completed to at least 0.01 percent (100 ppm) and certification expiration date.

15. Product Data for Global Green Tag: Product Health Data (PhD) containing inventory assessment completed to at least 0.1 percent (1000 ppm) and certification expiration date.

1.4 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For shop or field welding.

B. Product Certificates: For each type of code-compliance certification for studs and track.

C. Product Test Reports: For each listed product, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**] .

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

D. Research Reports:

1. For nonstandard cold-formed steel framing [**post-installed anchors**][**and**][**power-actuated fasteners**] , from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
2. For sill sealer gasket/termite barrier, showing compliance with ICC-ES AC380.

E. Qualification Statements: For testing agency.

F. Delegated Design Engineer Qualifications: For cold-formed steel framing.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by International Accreditation Service (IAS) to IAS AC98 criteria for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency [**, or in-house testing with calibrated test equipment,**] indicating steel sheet complies with requirements, including base-steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Track: Provide documentation that framing members are certified in accordance with the product-certification program of [**the Steel Framing Industry Association**][**the Steel Stud Manufacturers Association**][**the Supreme Steel Framing System Association**] .

D. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

E. Comply with AISI S230 for one- and two-family dwellings.

F. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**] where Project is located and who is experienced in providing engineering services of the type indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: [**As indicated on Drawings**] .
2. Deflection Limits: Design framing systems to withstand [**design loads**] without deflections greater than the following:

    a. Load-Bearing Wall Framing:

        1) Exterior: Horizontal deflection of [**1/240**][**1/360**][**1/600**][**1/720**] of the wall height.
        2) Interior: Horizontal deflection of [**1/240**][**1/360**] of the wall height under a horizontal load of **5 lbf/sq. ft. (239 Pa)**.

    b. Exterior Non-Load-Bearing Wall Framing: Horizontal deflection of [**1/240**][**1/360**][**1/600**][**1/720**] of the wall height.
    c. Interior Non-Load-Bearing Wall Framing: Horizontal deflection of [**1/240**][**1/360**] of the wall height under a horizontal load of **5 lbf/sq. ft. (239 Pa)**.
    d. Floor Joist Framing: Vertical deflection of [**1/360**][**1/480**] for live loads and l/240 for total loads of the span.
    e. Roof-Rafter Framing: Vertical deflection of [**1/120**][**1/240**][**1/360**] of the horizontally projected span for live loads.
    f. Ceiling Joist Framing: Vertical deflection of [**1/120**][**1/240**][**1/360**] of the span for live loads and 1/240 for total loads of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of **120 deg F (67 deg C)**.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

    a. Upward and downward movement of [**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch**

(25 mm)][1-1/2 inches (38 mm)] .

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and [**ASTM C955**][**AISI S200 and ASTM C955, Section 8**][**AISI S240**] .

D. Seismic Performance: Cold-formed steel framing to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7 and AISI S400**] .

E. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Product iQ" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

F. Sound-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, in accordance with ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 COLD-FORMED METAL FRAMING

A. Cold-Formed Steel Framing:

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

a. [**AllSteel & Gypsum Products, Inc.**]
b. [**CEMCO; California Expanded Metal Products Co.**]
c. [**ClarkDietrich**]
d. [**Consolidated Fabricators Corp.; Building Products Division**]
e. [**CRACO Mfg., Inc.**]
f. [**Design Shapes in Steel**]
g. [**Formetal Co. Inc. (The)**]
h. [**Jaimes Industries, Inc.**]
i. [**Marino\WARE**]
j. [**MBA Metal Framing**]
k. [**Mill Steel Framing; Mill Steel Company**]
l. [**MRI Steel Framing, LLC**]
m. [**Olmar Supply, Inc**]
n. [**Quail Run Building Materials, Inc.**]
o. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
p. [**State Building Products, Inc**]
q. [**Steel Construction Systems; Stone Group of Companies**]
r. [**Steel Network, Inc. (The)**]
s. [**Steeler, Inc**]
t. [**Super Stud Building Products Inc.**]
u. [**TELLING Industries**]
v. [**The Mill Steel Co**]
w. [**US Frame Factory**]

2. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of

preconsumer recycled content not less than 25 percent.

3. Framing Members, General: Comply with [**ASTM C955**][**AISI S200 and ASTM C955, Section 8**][**AISI S240**] for conditions indicated.
4. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

   a. Grade: [**ST33H (ST230H)**][**ST50H (ST340H)**][**As required by structural performance**] .

   b. Coating: [**G60 (Z180)**, **A60 (ZF180)**, **AZ50 (AZM150)**, **or GF30 (ZGF90)**][**G90 (Z275) or equivalent**] .

5. Steel Sheet for Vertical Deflection Drift Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

   a. Grade: [**33 (230)**][**50 (340)**, **Class 1**][**As required by structural performance**].
   b. Coating: **G90 (Z275)**.

2.3 LOAD-BEARING WALL FRAMING

A. Steel Studs, Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**] .

B. Steel Track, Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel studs**] .
2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**] .

C. Steel Box or Back-to-Back Headers, Load-Bearing Wall: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**] .

D. Steel Single- or Double-L Headers, Load-Bearing Wall: Manufacturer's standard L-shapes used to form header beams, of web depths indicated, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Top Flange Width: [**1-1/2 inches (38 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-

1/2 inches (63 mm)] .

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs, Exterior Non-Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**].

B. Steel Track, Exterior Non-Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel studs**] .
2. Flange Width: [**1-1/4 inches (32 mm)**].

C. Vertical Deflection Clips, Exterior: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

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

a. [**AllSteel & Gypsum Products, Inc.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Marino\WARE**]
e. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
f. [**Simpson Strong-Tie Co., Inc.**]
g. [**Steel Construction Systems; Stone Group of Companies**]
h. [**Steel Network, Inc. (The)**]

2. Clip Type: [**Bypass**][**Head**].

D. Single Deflection Track, Exterior: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Steel Thickness: [**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].
2. Flange Width: [**1 inch (25 mm) plus the design gap for one-story structures**][**and**][**1 inch (25 mm) plus twice the design gap for other applications**].

E. Drift Clips, Exterior: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs, Interior Non-Load-Bearing Wall: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-3/8 inches (35 mm)**][**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**] .

B. Steel Track, Interior Non-Load-Bearing Wall: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel studs**].
2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**] .

C. Vertical Deflection Clips, Interior: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

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

a. [**AllSteel & Gypsum Products, Inc.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Marino\WARE**]
e. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
f. [**Simpson Strong-Tie Co., Inc.**]
g. [**Steeler, Inc**]

2. Clip Type: [**Bypass**][**Head**] .

D. Single Deflection Track, Interior: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Steel Thickness: [**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].
2. Flange Width: [**1 inch (25 mm) plus the design gap for one-story structures**][**and**][**1 inch (25 mm) plus twice the design gap for other applications**].

E. Drift Clips, Interior: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 FLOOR JOIST FRAMING

A. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, [**unpunched**][**punched with standard holes**][**punched with enlarged service holes**] with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**] .

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

B. Steel Rim Joist Track: Manufacturer's standard U-shaped steel rim joist track, of web depths indicated, unpunched or punched at joist spacing, with unstiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**][**Matching steel joists**].

2. Flange Width: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**], minimum.

2.7 ROOF-RAFTER FRAMING

A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

2.8 SOFFIT FRAMING

A. Exterior Soffit Framing: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: [**0.0329 inch (0.84 mm)**][**0.0428 inch (1.09 mm)**][**0.0538 inch (1.37 mm)**][**0.0677 inch (1.72 mm)**][**0.0966 inch (2.45 mm)**][**0.1180 inch (2.997 mm)**].

2. Flange Width: [**1-5/8 inches (41 mm)**][**2 inches (51 mm)**][**2-1/2 inches (63 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**], minimum.

2.9 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic-coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.

2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.10 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process in accordance with ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, [**Grade 36**][**Grade 55**] , threaded carbon steel bolts, carbon-steel nuts, and flat, hardened-steel washers.

1. Bolt Type: [**Hex-headed bolts**][**Headless, hooked bolts**][**Headless bolts, with encased end threaded**]
2. Zinc Coating: [**Hot-dip process in accordance with ASTM A153/A153M, Class C**][**Mechanically deposition according to ASTM B695, Class 50**] .

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction.

1. Acceptance Criteria: [**ICC-ES AC01**][**ICC-ES AC193**][**ICC-ES AC58**][**ICC-ES AC308**] as appropriate for the substrate
2. Uses: Securing cold-formed steel framing to structure.
3. Type: [**Torque-controlled expansion anchor**][**Torque-controlled adhesive anchor**][**adhesive anchor**] .
4. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.
5. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ISO 3506-1)**, and nuts, **ASTM F594 (ISO 3506-1)**.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.11 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: [**ASTM A780/A780M**][**MIL-P-21035B**][**SSPC-Paint 20**] .

B. Cement Grout: Portland cement, ASTM C476, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sill Sealer Gasket: Closed-cell neoprene foam, **1/4 inch (6 mm)** thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

F. Sill Sealer Gasket/Termite Barrier: Minimum **68-mil (1.7-mm)** nominal thickness, self-adhering sheet consisting of **64 mils (1.6 mm)** of rubberized asphalt laminated on one side to a **4-mil- (0.10-mm-)** thick, polyethylene-film reinforcement, and with release liner on adhesive side [**; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction**] .

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

   a. [**Polyguard Products, Inc.**]

2. Physical Properties:

   a. Peel Adhesion: **17.0 lb/in (2.9 N/mm)** of width when tested in accordance with ASTM D412.
   b. Low-Temperature Flexibility: Pass at **minus 25 deg F (minus 32 deg C)** when tested in accordance with ASTM D146/D146M.
   c. Water Vapor Permeance: **0.05 perm (0.44 ng/Pa x s x sq. m)** maximum when tested in accordance with ASTM E96/E96M, Method B.
   d. Resistance to Termite Penetration: Comply with ICC-ES AC380.

2.12 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, in accordance with AISI S240 and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners and install in accordance with Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, in accordance with Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of **1/8 inch in 10 ft. (1:960)** and as follows:

1. Spacing: Space individual framing members no more than plus or minus **1/8 inch (3 mm)** from plan location. Cumulative errors are not to exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of **1/8 inch (3 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or track to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than **1/4 inch (6 mm)** to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Sill Sealer Gasket: Install at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

E. Sill Sealer Gasket/Termite Barrier: Install in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION OF COLD-FORMED STEEL FRAMING

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing in accordance with ASTM C1007, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding **1/16 inch (1.6 mm)**.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners, install in accordance with Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF LOAD-BEARING WALL FRAMING

A. Install continuous top and bottom track sized to match studs. Align track accurately and securely anchor at corners and ends, and at spacings as follows:

1. Anchor Spacing: [**As indicated on Shop Drawings**].

B. Squarely seat studs against top and bottom track, with gap not exceeding **1/8 inch (3 mm)** between the end of wall-framing member and the web of track.

1. Fasten both flanges of studs to top and bottom track.
2. Space studs as follows:

a. Stud Spacing: [12 inches (305 mm)][16 inches (406 mm)][19.2 inches (488 mm)][24 inches (610 mm)][**As indicated on Shop Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs in accordance with AISI S240, Section C3.5.2. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
2. Install track and jack studs above and below wall openings. Anchor track to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically [48 inches (1220 mm)][**as indicated on Drawings**][**as indicated on Shop Drawings**]. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed in accordance with manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom track. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION OF EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Install continuous track sized to match studs. Align track accurately and securely anchor to supporting

structure.

B. Fastening of Studs: Fasten both flanges of studs to [**top and**] bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Shop Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Single Deflection Track, Exterior: Install and anchor to building structure.
2. Vertical Deflection Clips, Exterior: Connect to [**bypassing**][**infill**] studs and anchor to building structure.
3. Drift Clips, Exterior: Connect to cold-formed steel framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated [**on Shop Drawings**] but not more than **48 inches (1220 mm)** apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel U-channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within [**12 inches (305 mm)**][**18 inches (450 mm)**] of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at [**96-inch (2440-mm) centers**][**centers indicated**][**centers indicated on Shop Drawings**] .

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INSTALLATION OF INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Install continuous track sized to match studs. Align track accurately and securely anchor to supporting structure.

B. Fastening of Studs: Fasten both flanges of studs to [**top and**] bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Drawings**].

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while

providing lateral support.

1. Single Deflection Track, Interior: Install and anchor to building structure.
2. Vertical Deflection Clips, Interior: Connect to studs and anchor to building structure.
3. Drift Clips, Interior: Connect to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated [**on Shop Drawings**] but not more than **48 inches (1220 mm)** apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within [**12 inches (305 mm)**][**18 inches (450 mm)**] of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at [**96-inch (2440-mm) centers**][**centers indicated**][**centers indicated on Shop Drawings**] .

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.7 INSTALLATION OF FLOOR JOIST FRAMING

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated [**on Shop Drawings**] .

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing as indicated on Shop Drawings.
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Space joists not more than **2 inches (51 mm)** from abutting walls, and as follows:

1. Joist Spacing: [**12 inches (305 mm)**][**16 inches (406 mm)**][**19.2 inches (488 mm)**][**24 inches (610 mm)**][**As indicated on Drawings**].

D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.

1. Install web stiffeners to transfer axial loads of walls above.

F. Bridging: Install bridging at intervals indicated [**on Shop Drawings**] . Fasten bridging at each joist intersection as follows:

1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.8 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of **1/8 inch in 10 ft. (1:960)** and as follows:

1. Space individual framing members no more than plus or minus **1/8 inch (3 mm)** from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.9 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Testing: the Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports, as directed by the Owner.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect, as directed by the Owner.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00 00

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Task	Specification	Specification Description
05 41 00 00	05 40 00 00	Cold-Formed Metal Framing
05 42 00 00	05 40 00 00	Cold-Formed Metal Framing
05 42 13 00	05 40 00 00	Cold-Formed Metal Framing
05 42 23 00	05 40 00 00	Cold-Formed Metal Framing
05 43 00 00	01 22 00 00	No Specification Required
05 43 00 00	05 40 00 00	Cold-Formed Metal Framing
05 43 00 00	05 05 19 00	Metal Fabrications
05 45 00 00	05 40 00 00	Cold-Formed Metal Framing
05 45 16 00	05 40 00 00	Cold-Formed Metal Framing

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SECTION 05 70 00 00 - DECORATIVE METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative window security bars.
2. Decorative mechanical grilles and frames.
3. Custom door pulls.
4. Combination hall push-button stations.
5. Metal reveals at wood paneling.
6. Cast-metal rosettes at marble joints.

B. Related Requirements:

1. Section 057300 "Decorative Metal Railings" for decorative metal railings.
2. Section 057500 "Decorative Formed Metal" for decorative metal items made from sheet metal.

1.2 COORDINATION

A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show fabrication and installation details for decorative metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.

E. Samples for Initial Selection: For products involving selection of color, texture, or design[**including mechanical finishes**].

F. Samples for Verification: For each type of exposed finish.

1. Sections of linear shapes.
2. Full-size Samples of castings and forgings.

a. For custom castings, submit finished Samples showing ability to reproduce detail[**, cast-metal color,**] and quality of finish.[**Samples may be of similar previous work.**]

3. Samples of [**welded**][**and**][**brazed**] joints showing quality of workmanship[**and color matching of materials**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**fabricator**][**organic-coating applicator**][**anodic finisher**][**powder-coating applicator**].

B. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Installer Qualifications: Fabricator of products.

C. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by enough packing material to ensure that products are not cracked or otherwise damaged.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Use materials with smooth, flat surfaces unless otherwise indicated. Use materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.2 ALUMINUM

A. Fabricate products from alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

B. Bars and Shapes: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

C. Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.

D. Tubing: **ASTM B210 (ASTM B210M)**, Alloy 6063-T832.

E. Plate and Sheet: **ASTM B209 (ASTM B209M)**, [**Alloy 3003-H14**][**Alloy 5005-H32**][**Alloy 6061-T6**].

F. Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.

G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.3 COPPER AND COPPER ALLOYS

A. Fabricate products from alloys indicated and temper to suit application and forming methods but with

strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.

2.4 BRONZE

A. Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).

B. Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).

C. Tube: **ASTM B135 (ASTM B135M)**, Alloy UNS C23000 (red brass, 85 percent copper).

D. Castings: [**ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)**][**or**][**ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)**].

E. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

2.5 BRASS

A. Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).

B. Seamless Tube: **ASTM B135 (ASTM B135M)**, Alloy UNS C26000 (cartridge brass, 70 percent copper).

C. Castings: ASTM B584, Alloy UNS C85200 (high-copper yellow brass).

D. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

2.6 NICKEL SILVER

A. Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.

B. Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).

2.7 COPPER

A. Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high residual phosphorous copper).

B. Castings: ASTM B824, with a minimum of 99.9 percent copper.

C. Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

2.8 STAINLESS STEEL

A. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**][**Grade MT 316L**].

B. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316**][**Grade TP 316L**].

C. Castings: ASTM A743/A743M, [**Grade CF 8 or Grade CF 20**][**Grade CF 8M or Grade CF 3M**].

D. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

E. Flat Bar: ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

F. Bars and Shapes: ASTM A276, [**Type 304**][**Type 316**][**Type 316L**].

G. Wire Rope and Fittings:

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

   a. [**Carl Stahl DecorCable, Inc.**]
   b. [**Esmet, Inc.**]
   c. [**Feeney Inc.**]
   d. [**Hayn Enterprises, LLC**]
   e. [**Johnson, C. Sherman, Co., Inc**]
   f. [**Ronstan International Inc**]
   g. [**Seco South, Inc.**]

2. Wire Rope: [**1-by-19**][**7-by-7**][**7-by-19**] wire rope made from wire complying with ASTM A492, Type 316.
3. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain without failure a load equal to minimum breaking strength of wire rope with which they are used.

2.9 STEEL AND IRON

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513, Type 5 (mandrel drawn)**].

C. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

D. Plates, Shapes, and Bars: ASTM A36/A36M.

E. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M unless otherwise indicated.

F. Steel Sheet, Cold Rolled: ASTM A1008/A1008M, either commercial steel or structural steel, exposed.

2.10 TITANIUM

A. Strip, Sheet, and Plate: ASTM B265, Grade 1.

B. Bars: ASTM B348, Grade 1.

2.11 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:

1. Aluminum Items: [**Aluminum**][**Type 304 stainless steel**][**Type 316 stainless steel**] fasteners.
2. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed, muntz metal (Alloy 280) fasteners where exposed**].
3. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed, brass (Alloy 260 or 360) fasteners where exposed**].
4. Stainless Steel Items: [**Type 304**][**Type 316**] stainless steel fasteners.
5. Titanium Items: [**Type 304**][**Type 316**] stainless steel fasteners.
6. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless steel fasteners where exposed.
7. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating.
8. Dissimilar Metals: [**Type 304**][**Type 316**] stainless steel fasteners.

B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable**].

1. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5 unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

2.12 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

F. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

G. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

H. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

I. Shop Primer for Galvanized Steel: [**Cementitious galvanized metal primer complying with MPI#26**][**Vinyl wash primer complying with MPI#80**][**Water-based galvanized metal primer complying with MPI#134**].

J. Intermediate Coats and Topcoats for Steel: Provide products that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

K. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.

L. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.

M. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.13 FABRICATION, GENERAL

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.
3. Use connections that maintain structural value of joined pieces.

B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged.

1. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes.
2. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

C. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

F. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

G. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to

weather in a manner to exclude water.

H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

I. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

J. Comply with AWS for recommended practices in shop [**welding**][**and**][**brazing**]. [**Weld**][**and**][**braze**] behind finished surfaces without distorting or discoloring exposed side. Clean exposed [**welded**][**and**][**brazed**] joints of flux, and dress exposed and contact surfaces.

1. Where [**welding**][**and**][**brazing**] cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for [**Type 1 Welds: no evidence of a welded joint**][**Type 2 Welds: completely sanded joint, some undercutting and pinholes okay**][**Type 3 Welds: partially dressed weld with spatter removed**][**Type 4 Welds: good quality, uniform undressed weld with minimal splatter**].

K. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

2.14 FABRICATION OF DECORATIVE WINDOW SECURITY BARS

A. Fabricate decorative window grilles to designs indicated from steel bars and shapes of sizes and profiles indicated. Form steel bars by bending, forging, coping, mitering, and welding.

B. Welding: Interconnect grille members with full-length, full-penetration welds unless otherwise indicated. Use welding method that is appropriate for metal and finish indicated and that develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.

C. Brackets, Fittings, and Anchors: Provide wall brackets, fittings, and anchors to connect decorative window grilles to other work unless otherwise indicated.

1. Furnish inserts and other anchorage devices to connect decorative window grilles to concrete and masonry work. Coordinate anchorage devices with supporting structure.
2. Fabricate anchorage devices that are capable of withstanding loads indicated.

2.15 DECORATIVE MECHANICAL GRILLES

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

1. [**Architectural Grille**]
2. [**Beaux-Arts Classic Products**]
3. [**DLSS Manufacturing**]
4. [**H&K Perforating LLC**]
5. [**Precision Metal Fabricators, Inc.**]
6. [**Reggio Register Company, Inc.**]
7. [**Register & Grille Mfg. Co., Inc.**]

B. Fabricate decorative grilles from perforated [**aluminum**][**brass**][**bronze**][**stainless steel**][**steel**] sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.

1. Form perforations to match existing grilles.
2. Drawings indicate perforated metal patterns required and are based on products of one manufacturer. Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

C. Drill and countersink grilles for mounting screws at **2 inches (50 mm)** from corners and at **10 inches (250 mm)** or less o.c. Provide units with oval-head [**wood**][**self-tapping machine**] screws.

D. Fabricate grille frames from extruded [**aluminum**][**brass**][**bronze**][**stainless steel**][**steel**] of profiles and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates [**welded**][**brazed**] to back of frames.

1. Secure grilles in frames with **0.5-inch- (12-mm-)** long [**welds**][**brazing**] along perimeter of grilles at **4 inches (100 mm)** o.c.
2. Provide frame profiles to match existing frames.
3. Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

E. Drill and countersink frames for mounting screws at **4 inches (100 mm)** from corners and at **16 inches (400 mm)** or less o.c. Provide units with oval-head [**wood**][**self-tapping machine**] screws.

2.16 FABRICATION OF CUSTOM DOOR PULLS

A. Fabricate custom door pulls from [**brass**][**bronze**][**stainless steel**] bar stock of profile indicated, fabricated to shapes indicated.

1. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces.
2. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile.
3. Drill and tap door pulls to receive through bolts for attachment to doors.

B. Fabricate backing plates for custom door pulls from **1/8-inch (3.2-mm)** [**brass**][**bronze**][**stainless steel**] sheet.

1. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal.
2. Drill and countersink holes where indicated for screws and bolts.

C. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.

2.17 FABRICATION OF COMBINATION HALL PUSH-BUTTON STATIONS

A. Fabricate units of [**brass**][**bronze**][**stainless steel**] to comply with details indicated. Coordinate with elevator signal equipment to provide integrated, closely fitted assemblies.

1. Fabricate faceplates from **1/8-inch- (3.2-mm-)** thick sheet with edges beveled at a 45-degree

angle for one-half thickness of metal.

2. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal **4-inch (100-mm)** wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are **10 by 10 by 3-1/2 inches (250 by 250 by 90 mm)** in depth.
3. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of **1/16 inch (1.6 mm)** with engraving painted red. Make signs **5 inches (125 mm)** wide by **8 inches (200 mm)** high.
4. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station[**, card reader,**] and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.

2.18 FABRICATION OF METAL REVEALS

A. Fabricate metal reveals for wood paneling from [**3/4-by-3/4-by-1/16-inch (19-by-19-by-3-mm) extruded-bronze**][**3/4-by-3/4-by-0.025-inch (19-by-19-by-0.6-mm) brake-formed, stainless steel**][**3/4-by-3/4-by-0.015-inch (19-by-19-by-0.4-mm) brake-formed titanium**] channels.

1. Drill for mounting screws **6 inches (150 mm)** from ends of channels and not more than **24 inches (600 mm)** o.c.
2. Locate mounting screws at same heights for all channels.
3. Provide [**black-finished,**]hex-socket, wafer-head screws for mounting reveals.

2.19 FABRICATION OF CAST-METAL ROSETTES

A. Fabricate cast-metal rosettes to design indicated from [**aluminum**][**brass**][**bronze**][**nickel silver**]. Drill and tap castings for threaded mounting studs.

1. Provide custom castings to match design indicated.
2. Manufacturer's stock castings may be considered, provided deviations are minor and do not change design concept as directed by the Owner.
3. Drawings indicate cast-metal rosette designs required and are based on products of one manufacturer. Castings produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as directed by the Owner.

2.20 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.21 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
2. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Superior-Performance Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.22 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).

D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).

F. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

I. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**, with color matching Architect's sample**].

K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate)[**, with color matching Architect's sample**].

L. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below)[**, with color matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

M. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air dried; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below)[**, with blackening and buffing matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

2.23 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirror-like finish**][**to match Architect's sample**].

D. Stainless Steel Sheet and Plate Finishes:

1. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.
2. Directional Satin Finish: ASTM A480/A480M, No. 4.
3. Dull Satin Finish: ASTM A480/A480M, No. 6.
4. High Luster Finish: ASTM A480/A480M, No. 7.
5. Mirror Finish: ASTM A480/A480M, No. 8.

E. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

F. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.

G. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.

1. Product: Subject to compliance with requirements, provide INCO colored stainless steel finish as developed and licensed by International Nickel Co., Ltd.
2. Color: [**Match Architect's sample**][**As selected by Architect from finisher's full range**].

2.24 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A123/A123M.

1. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A153/A153M.
2. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

C. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."**][**requirements indicated below:**]

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

D. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated ferrous-metal surfaces with [**universal shop primer**][**primers specified in Section 099113 "Exterior Painting."**][**primers specified in Section 099123 "Interior Painting."**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-**

Performance Coatings" are] indicated.
2. Do not apply primer to galvanized surfaces.

E. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Powder-Coat Finish, Nongalvanized: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. Powder-Coat Finish, Galvanized: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.25 TITANIUM FINISHES

A. General: Fabricate items from finished titanium stock, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.

B. Dull Matte Finish: Pickled and annealed.

C. Bright Matte Finish: Vacuum annealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

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

3.2 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

H. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.

I. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 INSTALLATION OF DECORATIVE WINDOW SECURITY BARS

A. Fasten security bar frames to concrete and masonry walls with cast-in-place or post-installed anchors. Peen exposed threads of anchors to prevent removal of security bars.

3.4 INSTALLATION OF DECORATIVE MECHANICAL GRILLES

A. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.

1. Secure to framing and blocking with specified fasteners.
2. On marble, brick, and other solid surfaces, secure with wood screws in plastic plugs.

3.5 INSTALLATION OF DECORATIVE-METAL-CLAD, HOLLOW-METAL DOORS AND FRAMES

A. Install doors and frames to comply with requirements specified in Section 081113 "Hollow Metal Doors and Frames."

3.6 INSTALLATION OF CUSTOM DOOR PULLS

A. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head [**wood**][**self-tapping metal**] screws and secure pulls through doors and backing plates with oval-head machine screws.

3.7 INSTALLATION OF COMBINATION HALL PUSH-BUTTON STATIONS

A. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components. Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.

3.8 INSTALLATION OF METAL REVEALS AT WOOD PANELING

A. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.

3.9 INSTALLATION OF CAST-METAL ROSETTES AT MARBLE JOINTS

A. Install cast-metal rosettes at intersections of marble joints where indicated. Install only after marble work is complete and joints are grouted. Secure to wall by drilling a **3/4-inch- (19-mm-)** round hole at intersection of marble joints and by filling hole with molding plaster into which threaded stud is embedded. Angle drill and rotate so bottom of hole is larger than at surface.

1. Secure rosettes in place with masking tape until plaster sets. After plaster has set, remove masking tape and adhesive residue.

3.10 CLEANING AND PROTECTION

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

E. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.

F. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

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SECTION 05 71 00 00 - DECORATIVE METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes decorative metal stairs.

B. Related Requirements:

1. Section 057113 "Fabricated Metal Spiral Stairs."
2. Section 093013 "Ceramic Tiling" for ceramic-tile treads and landings.
3. Section 096340 "Stone Flooring" for stone treads and landings.
4. Section 096400 "Wood Flooring" for wood treads and landings.
5. [**Section 096613 "Portland Cement Terrazzo Flooring"**][**Section 096623 "Resinous Matrix Terrazzo Flooring"**] for field-cast terrazzo treads and landings.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs.

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Shop primer products.
2. Precast concrete treads.
3. Precast terrazzo treads.
4. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means

of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.

D. Samples for Verification: For each type and finish of tread.

E. Delegated Design Submittal: For stairs, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the [**jurisdiction**][**State**] in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs,[**and railings,**] including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: **100 lbf/sq. ft. (4.79 kN/sq. m)**.
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to [**L/360**][**L/720**] or **1/4 inch (6.4 mm)**, whichever is less.

C. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

2.2 METALS

A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Steel Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M**].

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

D. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316L**].

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

E. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M,[**either commercial steel, Type B, or**] structural steel, **Grade 25 (Grade 170)**, unless another grade is required by design loads; exposed.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

F. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M,[**either commercial steel, Type B, or**] structural steel, **Grade 30 (Grade 205)**, unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

G. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating,[**either commercial steel, Type B, or**] structural steel, **Grade 33 (Grade 230)**, unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

H. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], stretcher-leveled standard of flatness.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

I. Bronze Sheet: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper) or Alloy UNS C23000 (red brass, 85 percent copper).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

J. Brass Sheet: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

K. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

L. Titanium Sheet: ASTM B265, Grade 1.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

M. Aluminum Sheet: Flat sheet complying with **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties of not less than Alloy 5005-H32.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

N. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T6.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

O. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

1. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**] percent.

P. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

Q. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

R. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

S. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

T. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.3 ABRASIVE NOSINGS

A. Cast-Metal Units: Cast [**iron**][**aluminum**][**bronze**][**nickel silver**], with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

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

   a. [**American Safety Tread Co., Inc**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Barry Pattern & Foundry Co., Inc**]
   d. [**Granite State Casting Co**]
   e. [**Safe-T-Metal Company, Inc.**]
   f. [**TrueNorth Steel**]
   g. [**Wooster Products Inc**]

2. Configuration: Cross-hatched units, [**3 inches (75 mm)**][**4 inches (100 mm)**] wide without lip.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

B. Extruded Units: [**Aluminum**][**Bronze**] units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**American Safety Tread Co., Inc**]
b. [**Amstep Products**]
c. [**Armstrong Products, Inc**]
d. [**Balco; a CSW Industrials Company**]
e. [**Ecoglo, Inc.**]
f. [**Granite State Casting Co**]
g. [**Nystrom, Inc.**]
h. [**UPNOVR, Inc.**]
i. [**Wooster Products Inc**]

2. Provide ribbed units, with abrasive filler strips projecting **1/16 inch (1.5 mm)** above aluminum extrusion.
3. Provide solid-abrasive units without ribs.
4. Nosings: Square-back units, [**1-7/8 inches (48 mm)**][**3 inches (75 mm)**][**4 inches (100 mm)**] wide, without lip.
5. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

2.4 FASTENERS

A. General: Provide [**zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5**][**Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5**] where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for [**exterior stairs**][**stairs indicated to be galvanized**][**stairs indicated to be shop primed with zinc-rich primer**].

D. Post-Installed Anchors: [**Torque-controlled expansion anchors**][**or**][**chemical anchors**] capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, **ASTM F594 (ASTM F836M)**.

2.5 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

D. Zinc-Rich Primer: Complying with SSPC-Paint 20, [**Type I-A**][**Type I-B**][**Type I-C**][**Type II**], Level [**1**][**2**][**3**], and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with [**SSPC-Paint 20**][**ASTM A780/A780M**] and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of **3000 psi (20 MPa)** unless otherwise indicated.

I. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

J. Plain Steel Welded-Wire Reinforcement: ASTM A1064/A10645M, [**steel,**][**galvanized steel,**] **6 by 6 inches (152 by 152 mm)**, W1.4 by W1.4, unless otherwise indicated on Drawings.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

K. Reinforcement Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete.
2. For galvanized reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

L. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for [**interior**][**exterior**] use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

2.6 PRECAST CONCRETE TREADS

A. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of **5000 psi (35 MPa)** and a total air content of not less than 4 percent or more than 6 percent.

B. Reinforcement: Galvanized, welded-wire reinforcement, **2 by 2 inches (50 by 50 mm)** by **0.062-inch-(1.6-mm-)** diameter steel wire; comply with ASTM A1064/A1064M, except for minimum wire size.

2.7 PRECAST TERRAZZO TREADS

A. Precast Terrazzo Stair Treads: Epoxy terrazzo units cast in maximum lengths possible. Comply with manufacturer's written instructions for fabricating precast terrazzo units in sizes and profiles indicated.

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

a. [**Wausau Tile, Inc.**]

2. Epoxy Resin Matrix: Manufacturer's standard, recommended for use indicated.
3. Aggregates: Comply with NTMA gradation standards for mix indicated, and containing no deleterious or foreign matter.

a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
b. 24-Hour Absorption Rate: Less than 0.75 percent.
c. Dust Content: Less than 1.0 percent by weight.

4. Reinforcement: ASTM A615/A615M, **Grade 60 (Grade 420)** bars, as required by unit size, profile, and thickness.
5. Abrasive Inserts: **1/2-inch- (13-mm-)** wide, alundum oxide/epoxy mixture.

a. Provide three inserts, **1/2 inch (13 mm)** apart, with first insert located **1 inch (25 mm)** from nosing at adjacent stair riser locations.

6. Color: As selected from manufacturer's standard color selections.
7. Finish: Honed.
8. Surface Sealer: Slip and stain-resistant, penetrating sealer that is chemically neutral with pH factor between 7 and 12; does not affect color or physical properties of terrazzo type indicated; is recommend by sealer manufacturer for use with specified terrazzo; and complies with NTMA guide specification for terrazzo type applicable for this Project.

2.8 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.

2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.

2.9 FABRICATION OF STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Stringers: Fabricate of [**steel plates**][**steel channels**][**steel plates or channels**][**steel tubes**][**as indicated on Drawings**].

   a. Stringer Size: [**As required to comply with "Performance Requirements" Article**][**As indicated on Drawings**].
   b. Provide closures for exposed ends of [**channel**][**tube**] stringers.
   c. Finish: [**Shop primed**][**Painted**][**Galvanized**].

2. Platforms: Construct of steel [**plate**][**channel**][**plate or channel**][**rectangular tube**] headers and miscellaneous framing members as [**required to comply with "Performance Requirements" Article**][**indicated on Drawings**].

   a. Provide closures for exposed ends of [**channel**][**tube**] framing.
   b. Finish: [**Shop primed**][**Painted**][**Galvanized**].

3. Weld[**or bolt**] stringers to headers; weld[**or bolt**] framing members to stringers and headers.[**If using bolts, fabricate and join so bolts are not exposed on finished surfaces.**]

C. Subtreads, Risers, and Subplatforms:

1. Fabricate subtreads and subplatforms of steel [**plates**][**shapes indicated on Drawings**].
2. Form subtreads, risers, and subplatforms to configurations indicated from [**uncoated, cold-rolled steel sheet**][**uncoated, hot-rolled steel sheet**][**galvanized steel sheet**][**of thickness needed**

to comply with performance requirements, but not less than 0.075 inch (1.9 mm) thick][of thickness indicated on Drawings].

3. Weld subtreads to stringers.

    a. Locate welds on top of subtreads where they will be concealed by finished treads.

4. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads.

    a. Weld subplatforms to platform framing.
    b. Locate welds on top of subplatforms where they will be concealed by finished flooring.
    c. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

2.10 STAIR RAILINGS

A. Comply with applicable requirements in Section 057300 "Decorative Metal Railings."

1. Connect posts to stair framing by direct welding unless otherwise indicated.

2.11 FINISHES

A. Finish metal stairs after assembly.

B. Steel Galvanized Finish: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Steel Shop Prime Finish:

1. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."**][**SSPC-SP 3, "Power Tool Cleaning."**]
2. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting.

    a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

D. Aluminum Finishes:

1. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.
2. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

    a. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].

E. Stainless Steel Finishes:

1. Stainless Steel Tubing Finishes:

a. 180-Grit Polished Finish: Uniform, directionally textured finish.
b. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
c. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirror-like finish**][**to match Architect's sample**].

2. Stainless Steel Sheet and Plate Finishes:

a. Directional Satin Finish: ASTM A480/A480M, No. 4.
b. High Luster Finish: ASTM A480/A480M, No. 7.
c. Mirror Finish: ASTM A480/A480M, No. 8.

F. Bronze Finishes:

1. Statuary Conversion Coating over Satin Finish: CDA M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**, with color matching Architect's sample**].
2. Statuary Conversion Coating over Satin Finish, Lacquered: CDA M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air dried, as specified below)[**, with color matching Architect's sample**]:

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

3. Hand-Rubbed Finish, Lacquered: CDA M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Brass Finishes:

1. Buffed Finish, Lacquered: CDA M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

2. Hand-Rubbed Finish, Lacquered: CDA M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Copper Finishes:

1. As Fabricated: CDA M12 (Matte finish as fabricated).
2. Buffed Finish: CDA M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: CDA M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: CDA M32 (Mechanical Finish: directionally textured, medium satin).

5. Fine-Matte Finish: CDA M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: CDA M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

7. Hand-Rubbed Finish, Lacquered: CDA M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

8. Medium-Satin Finish, Lacquered: CDA M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

9. Fine-Matte Finish, Lacquered: CDA M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).

    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

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

3.2 INSTALLING METAL STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

    1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.

a. Clean bottom surface of plates.
b. Set plates for structural members on wedges, shims, or setting nuts.
c. Tighten anchor bolts after supported members have been positioned and plumbed.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

F. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete.
2. Center nosings on tread width.

G. Install precast concrete treads with adhesive supplied by manufacturer.

H. Install precast terrazzo treads according to manufacturer's written instructions.

3.3 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 71 00 00

Task	Specification	Specification Description
05 71 00 00	05 70 00 00	Decorative Metal

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SECTION 05 71 13 00 - FABRICATED METAL SPIRAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fabricated metal spiral stairs with steel central-supporting columns, radiating treads, and railings.

B. Related Requirements:

1. Section 062023 "Interior Finish Carpentry" for wood treads.
2. Section 096513 "Resilient Base and Accessories" for resilient treads.
3. Section 096816 "Sheet Carpeting" for carpeting treads.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for fabricated metal spiral stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate fabricated metal spiral stairs with finish flooring materials.

1.3 ACTION SUBMITTALS

A. Product Data: For fabricated metal spiral stairs, including railings. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for components.

B. Shop Drawings: For fabricated metal spiral stairs and railings. Include plans, elevations, sections, details, attachments to other work, and field measurements.

C. Samples for Initial Selection: For products involving selection of color, texture, or design.

D. Samples for Verification: For the following products, in manufacturer's standard sizes:

1. Treads.
2. Metal with painted finish.
3. Railing members.

E. Delegated Design Submittal: For fabricated metal spiral stairs and railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content

and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with fabricated metal spiral stairs by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fabricated metal spiral stairs from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fabricated metal spiral stairs and railings.

B. Structural Performance of Stairs: Fabricated metal spiral stairs are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]:

1. Uniform Load: [**40 lbf/sq. ft. (1.92 kN/sq. m)**][**100 lbf/sq. ft. (4.79 kN/sq. m)**].
2. Concentrated Load: **300 lbf (1.33 kN)** applied on an area of **4 sq. in. (2580 sq. mm)**.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Railing Loads: Stairs are to withstand stresses resulting from railing loads in addition to loads specified above.
5. Deflection: Limit deflection of treads, landings, and framing members to [**L/360**] but not to exceed [**1/4 inch (6 mm)**].

C. Structural Performance of Railings: Railings are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**]:

1. Handrails and Top Rails of Guards:

   a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
   b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

   a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
   b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance: Fabricated metal spiral stairs are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**].

2.3 SPIRAL STAIRS

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

1. [**Accent Stairs; ADPG, LLC**]
2. [**Boston Stair**]
3. [**Couturier Iron Craft, Inc.**]
4. [**Custom Iron**]
5. [**Duvinage LLC**]
6. [**Goddard Manufacturing**]
7. [**Innovative Metalcraft, LLC**]
8. [**Iron Shop (The)**]
9. [**Mylen Stairs**]
10. [**Salter Spiral Stair**]
11. [**Stairways Inc.**]
12. [**Steptoe & Wife Antiques Ltd**]

B. Center Column: [**Steel**][**or**][**aluminum**] pipe welded to baseplate for anchorage to floor structure. Brace column at upper floors by means of landings attached to column and floor structure unless otherwise indicated. Provide cap for column if top is exposed.

C. Treads, Cast Metal: Cast [**aluminum**][**iron**] treads[**and platforms**] with integral frames, legs, and hubs.

1. Provide treads[**and platforms**] with abrasive surfaces.

D. Treads, Metal Bar Grating: Steel-bar grating treads[**and platforms**] with welded hubs and as follows:

1. Radial grating treads.
2. [**Abrasive**][**Rolled-steel, floor-plate**] nosings.
3. Straight flanges and welded-on legs.
4. Tapered flanges without legs.

E. Treads, Formed Metal Plate: Formed [**steel-**][**aluminum-**]plate treads[**and platforms**], welded to hubs or center column, and as follows:

1. Straight flanges and welded-on legs.
2. Tapered flanges without legs.
3. Pan treads without legs.
4. One-piece treads and risers, [**with**][**without**] legs.
5. Rolled-steel, floor-plate wearing surfaces.
6. Aluminum-alloy, rolled tread-plate wearing surfaces.
7. Smooth steel-plate wearing surfaces.
8. Rubber wearing surfaces.
9. Plywood subtread for covering with finish flooring specified in another Section.

F. Treads, Metal Framed: Steel-framed treads[**and platforms**], welded to hubs or center column, and without legs; wearing surface as follows:

1. Cast iron with integral abrasive.
2. Smooth steel plate with integral abrasive.
3. Wood.
4. Plywood insert for covering with finish flooring specified in another Section.

G. Railings: Uniformly bent to spiral shape[**, and continuing at top to form guardrail around floor opening**].

1. Space balusters less than [**4 inches (102 mm)**][**4-3/8 inches (111 mm)**], clear.
2. Space balusters to provide one baluster per tread, and less than [**21 inches (533 mm)**][**30 inches (762 mm)**], clear.
3. Space intermediate rails less than [**4 inches (101 mm)**][**4-3/8 inches (111 mm)**][**21 inches (533 mm)**], clear.
4. Locate bottom rail so that a [**6-inch- (152-mm-)**]diameter sphere cannot pass between the stair and rail.
5. Hand Rail:

    a. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] steel [**pipe**][**or**][**round tubing**].
    b. Steel of shape and size indicated.
    c. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] round [**aluminum**][**bronze**][**brass**][**stainless steel**] tubing.
    d. Extruded bronze of shape and size indicated.
    e. Wood of shape and size indicated.

6. Top Rail:

   a. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] steel [**pipe**][**or**][**round tubing**].
   b. Steel of shape and size indicated.
   c. [**1-1/4- to 2-inch- (32- to 51-mm-) OD**] round [**aluminum**][**bronze**][**brass**][**stainless steel**] tubing.
   d. Extruded bronze of shape and size indicated.
   e. Wood of shape and size indicated.

7. Balusters:

   a. [**7/8-inch- (22-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] steel pipe[**or round tubing**].
   b. [**1/2-inch- (13-mm-) OD**][**5/8-inch- (16-mm-) OD**] round steel [**bars**][**tubing**].
   c. [**1/2-inch- (13-mm-)**][**5/8-inch- (16-mm-)**][**3/4-inch- (19-mm-)**] square steel [**bars**][**tubing**].
   d. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**] round aluminum tubing.

8. Intermediate Rails:

   a. [**7/8-inch- (22-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] steel pipe[**or round tubing**].
   b. Steel pipe[**or round tubing**] same size as top rail.
   c. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**] round steel [**bars**][**tubing**].
   d. [**5/8-inch- (16-mm-) OD**][**3/4-inch- (19-mm-) OD**][**1-inch- (25-mm-) OD**][**1-1/4-inch- (32-mm-) OD**] round aluminum tubing.
   e. Round aluminum tubing same size as top rail.

2.4 MATERIALS

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Brackets, Flanges, and Anchors: Same metal and finish as supported item unless otherwise indicated.

D. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

E. Steel Bars for Grating Treads and Platforms: ASTM A36/A36M or ASTM A1011/A1011M.

F. Wire Rod for Grating Crossbars: ASTM A510/A510M.

G. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or Grade D.

H. Steel Pipe Columns: ASTM A53/A53M, Schedule 40. Provide Schedule 80 for columns larger than **NPS 4 (DN 100)** and where required to support loads.

I. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

J. Steel Tubing: Either cold-formed steel tubing complying with ASTM A500/A500M or mandrel-drawn mechanical tubing complying with ASTM A513, Type 5.

K. Iron Castings: Either gray iron complying with ASTM A48/A48M or malleable iron complying with ASTM A47/A47M unless otherwise indicated or required by structural loads.

L. Aluminum Sheet and Plate: **ASTM B209 (ASTM B209M)**, Alloy 6061-T6.

M. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

N. Aluminum Pipe and Structural Round Tubing: ASTM B429/B429M, Alloy 6063-T6.

O. Extruded-Aluminum Tubing: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

P. Aluminum Castings: ASTM B26/B26M, Alloy 319.0-F.

Q. Extruded-Bronze Handrails: ASTM B455, Alloy UNS No. C38500 (architectural bronze).

R. Seamless Bronze Tubing: ASTM B135/B135M, Alloy UNS No. C23000 (red brass, 85 percent copper).

S. Seamless Brass Tubing: ASTM B135/B135M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).

T. Stainless Steel Tubing: ASTM A554, Grade MT 304.

U. Stainless Steel Sheet: Sheet, Strip, Plate, and Flat Bar: ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

V. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316**][**Type 316L**].

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: For connecting stair components and for anchoring stairs to other construction, select fasteners of type, grade, and class required to produce connections capable of withstanding design loadings.

1. For aluminum, provide fasteners fabricated from Type 304 stainless steel.
2. For stainless steel, provide fasteners fabricated from Type 304 stainless steel.
3. For steel and cast iron, use plated steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating.
4. For exterior locations, provide fasteners fabricated from Type 304 stainless steel.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

C. Lacquer for Brass and Bronze: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products.

1. Product: Subject to compliance with requirements, provide "Incralac" developed by International Copper Research Corporation.

D. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**]

E. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with finish paint systems indicated.

F. Shop Primer for Galvanized Steel: Primer formulated for use over zinc-coated metal and compatible with finish paint systems indicated.

G. Shop Primer for Aluminum: Primer formulated for use over aluminum and compatible with finish paint systems indicated.

H. Wood for Stair Treads, Handrails, and Platforms: Laminated red oak, sanded to 120-grit smoothness. Apply uniform coat of manufacturer's standard clear sealer.

I. Rubber Wearing Surfaces: Manufacturer's standard, **1/4-inch- (6-mm-)** thick, molded-rubber covering in pattern and color indicated or, if not indicated, as selected by Architect from manufacturer's standard colors and patterns.

2.6 FABRICATION

A. Assemble fabricated metal spiral stairs in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form work true to line and level with accurate angles and surfaces.

D. Fabricate connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

E. Cut, reinforce, drill, and tap as needed to receive hardware, screws, and similar items.

F. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. Finish exposed welds to comply with NOMMA Guideline 1, "Joint Finishes," for [**Finish #1 -No evidence of a welded joint**][**Finish #2 - Completely sanded joint, some undercutting and pinholes okay**][**Finish #3 - Partially dressed weld with spatter removed**].
5. Finish exposed surfaces smooth and blended and, except for fillet welds, so welded surface matches contours of adjoining surfaces.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.7 STEEL AND IRON FINISHES

A. Galvanized Finish: Hot-dip galvanize fabricated metal spiral stairs and railings after fabrication to comply with ASTM A123/A123M.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6 (WAB)/NACE WAB-3, "Commercial Blast Cleaning."**][**SSPC-SP 7 (WAB)/NACE WAB-4, "Brush-off Blast Cleaning."**]

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter; treat with etching cleaner [**or**][**in accordance with SSPC-SP 16**].

D. Apply shop primer to prepared surfaces of handrails and railing components unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

2.8 ALUMINUM FINISHES

A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color:

a. [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
b. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (cleaned with inhibited chemicals; acid chromate-fluoride-phosphate conversion coating; shop primer).

1. Apply shop primer with a minimum dry film thickness of **1.5 mils (0.04 mm)**.

E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.9 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirrorlike finish**][**to match Architect's sample**].

D. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.
2. High Luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

2.10 BRASS AND BRONZE FINISHES

A. Buffed Finish: Mirror polished, buffed finish.

B. Lacquered Buffed Finish: Mirror polished, buffed finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

C. Lacquered Medium-Satin Finish: Directionally textured, medium satin, mechanical finish coated with lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

D. Statuary Conversion Coating over Satin Finish: Directionally textured, fine satin, mechanical finish with sulfide conversion coating.

1. Color Match: Match Architect's sample, as directed by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where needed for securing fabricated metal spiral stairs to in-place construction; include threaded fasteners for concrete and masonry inserts, through bolts, lag bolts, wood screws, and other connectors as required.

B. Assemble fabricated metal spiral stair components to comply with manufacturer's written instructions, with each component aligned and in correct relation to each other, securely anchored to supporting column and adjacent structure.

C. Do not cut, alter, or drill stair components in the field that do not fit properly. Return components that do not fit to manufacturer for adjustment.

D. Install fabricated metal spiral stairs accurately in location, alignment, and elevation; level and plumb; and in accordance with manufacturer's written instructions.

E. Install fabricated metal spiral stairs by welding to steel structure or to weld plates cast into concrete unless otherwise indicated.

F. Field Welding:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

3.2 REPAIR

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material.

B. For galvanized surfaces, clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

1. Paint repaired areas with same material used for shop painting.

3.3 PROTECTION

A. Protect finished tread surfaces during construction by covering with **1/2-inch- (13-mm-)** thick, plywood secured with plastic strapping or another nonmarring fastening method.

END OF SECTION 05 71 13 00

Task	Specification	Specification Description
05 71 13 00	05 70 00 00	Decorative Metal
05 71 13 00	05 71 00 00	Decorative Metal Stairs

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SECTION 05 73 00 00 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum decorative railings.
2. Copper-alloy decorative railings.
3. Stainless steel decorative railings.
4. Steel and iron decorative railings.

B. Related Requirements:

1. Section 055213 "Pipe and Tube Railings" for nonornamental railings fabricated from pipes and tubes.
2. Section 057313 "Glazed Decorative Metal Railings."
3. Section 061000 "Rough Carpentry" for wood blocking for anchoring railings.
4. [**Section 064013 "Exterior Architectural Woodwork"**][**Section 064023 "Interior Architectural Woodwork"**] for wood railings.

1.2 COORDINATION AND SCHEDULING

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's product lines of decorative metal railings assembled from standard components.
2. Illuminated rails.
3. Stainless steel cable and cable fittings.
4. Expanded metal infill panels.
5. Perforated metal infill panels.
6. Woven-wire mesh infill panels.
7. Fasteners.
8. Post-installed anchors.
9. Handrail brackets.
10. Wood rails.

11. Lacquer for copper alloys.
12. Shop primer.
13. Intermediate coats and topcoats.
14. Bituminous paint.
15. Nonshrink, nonmetallic grout.
16. Anchoring cement.
17. Metal finishes.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Include plans, elevations, sections, and attachment details.

1. For illuminated railings, include wiring diagrams and roughing-in details.

D. Samples for Initial Selection: For products involving selection of color, texture, or design[**, including mechanical finishes**].

E. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters
2. Illuminated railing.
3. Fittings, end caps, and brackets.
4. Welded connections.
5. Brazed connections.
6. Cable and cable hardware and connections.
7. Assembled Sample of railing system, made from full-size components, including top rail, post, [**illuminated**] handrail, and guard infill. Sample need not be full height.

a. Show method of [**connecting**][**and**][**finishing**] members at intersections.

F. Delegated Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**delegated design professional engineer**][**testing agency**].

B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

F. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable

to authorities having jurisdiction.

G. Preconstruction test reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups as shown on Drawings.
2. Build mockups for each form and finish of railing, consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than **24 inches (600 mm)** in length.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made [**the Owner**][**from the testing and inspecting allowance, as authorized by Change Orders**][**by Contractor**]. Retesting of products that fail to meet specified requirements is to be done at Contractor's expense.

1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
2. Test railings in accordance with ASTM E894 and ASTM E935.
3. Notify Architect [**seven**] days in advance of the dates and times when laboratory mockups will be tested, as directed by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.3 ALUMINUM DECORATIVE RAILINGS

A. Aluminum Decorative Railings:

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

a. [**American Structures & Design**]
b. [**Architectural Iron Designs, Inc.**]
c. [**ATR Technologies, Inc.**]
d. [**AZEK Building Products, Incorporated**]
e. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
f. [**CraneVeyor Corp**]
g. [**Feeney Inc.**]

h. [**Greco; CSW Industrials Inc.**]
i. [**HDI Railings**]
j. [**Hollaender Architectural Railing Systems; Hollaender Mfg. Co.**]
k. [**Hollaender Mfg. Co.**]
l. [**Julius Blum & Co., Inc.**]
m. [**Kane Innovations, Inc.**]
n. [**Knotwood US LLC**]
o. [**Livers Bronze Co.**]
p. [**Promenaid**]
q. [**Regal Ideas, Inc.**]
r. [**Seco South, Inc.**]
s. [**Superior Aluminum Products, Inc**]
t. [**Thompson Fabricating, LLC**]
u. [**Trex Commercial Products, Inc.**]
v. [**Tri Tech, Inc.**]
w. [**Tuttle, a Dant Clayton Division**]
x. [**VIVA Railings, LLC**]
y. [**Wagner Companies (The); R&B Wagner, Inc.**]
z. [**Wylie Metals**]

2. Source Limitations: Obtain aluminum decorative railing components from single source from single manufacturer.

B. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

C. Extruded Bars and Shapes, Including Extruded Tube: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

D. Extruded Structural Pipe and Round Tube: ASTM B429/B429M, Alloy 6063-T6.

1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

E. Drawn Seamless Tube: ASTM B210/B210M, Alloy 6063-T832.

F. Plate and Sheet: **ASTM B209 (ASTM B209M)**, [**Alloy 5005-H32**][**Alloy 6061-T6**].

G. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.

H. Illuminated [**Top**][**Hand**] Rails: Provide internal illumination using concealed, internally wired, integrated LED [**dimmable**] lamps to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service.

1. LED Luminaires: Comply with [**Section 265119 "LED Interior Lighting"**][**Section 265619 "LED Exterior Lighting"**] and as follows:

a. Lamp Type: [**Linear**][**Point**].
b. Light Illumination: White, [**standard**][**high**] output; [**80 lumens/300 mm**][**120 lumens/300 mm**][**270 lumens/300 mm**].
c. Efficacy: Minimum [**80**] lm/W.
d. Color Rendering Index: Minimum [**65**][**70**][**80**].
e. Correlated Color Temperature: [**2700 K**][**3000 K**][**3500 K**].
f. Rated Lamp Life: [**50,000**] hours at 70 percent lamp illumination output.
g. Beam Distribution: [**Symmetric**][**Asymmetric**][**10 degrees**][**25 degrees**][**55 degrees**][**100 degrees**].

h. LED Diffuser: UV-stabilized acrylic, [**clear**][**translucent**], matching rail profile.
i. Nominal Operating Voltage: [**120 V ac**][**277 V ac**] input; [**12 V dc**][**24 V dc**] output.
j. Internal Driver: [**100**][**120**] W.
k. UL Listing: [**Damp**][**Dry**].
l. IP Rating: IP67.
m. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Stainless Steel Cable and Cable Fittings for Aluminum Decorative Railings:

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

a. [**Bergen Cable Technology, LLC**]
b. [**Carl Stahl DecorCable, Inc.**]
c. [**Esmet, Inc.**]
d. [**Feeney Inc.**]
e. [**Hayn Enterprises, LLC**]
f. [**Johnson, C. Sherman, Co., Inc**]
g. [**Loos & Co. Inc.**]
h. [**Morse Industries**]
i. [**Ronstan International Inc**]
j. [**Seco South, Inc.**]
k. [**Ultra-tec; The Cable Connection**]
l. [**VIVA Railings, LLC**]

2. Cable: [**1-by-19**][**7-by-7**][**7-by-19**] wire cable made from wire complying with ASTM A492, Type 316[**, PVC jacketed**].
3. Cable Diameter: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4inch (6.4 mm)**].
4. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.
5. Intermediate Cable Supports: Stainless steel flat bar, **1/4 by 1 inch (6.4 by 25.4 mm)**, predrilled.

J. Castings: ASTM B26/B26M, Alloy A356.0-T6.

K. Perforated Metal Infill Panels: Aluminum sheet, **ASTM B209 (ASTM B209M)**, Alloy 6061-T6, [**0.063 inch (1.60 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8-inch (9.5-mm) o.c. in staggered rows**].

L. Woven-Wire Mesh Infill Panels: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.162-inch (4.1-mm)** nominal diameter aluminum wire complying with ASTM B211/B211M, Alloy 6061-T94.

2.4 COPPER-ALLOY DECORATIVE RAILINGS

A. Copper-Alloy Decorative Railings:

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

a. [**Architectural Iron Designs, Inc.**]
b. [**CraneVeyor Corp**]
c. [**Julius Blum & Co., Inc.**]
d. [**Lavi Industries**]
e. [**Livers Bronze Co.**]
f. [**Tri Tech, Inc.**]
g. [**Wagner Companies (The); R&B Wagner, Inc.**]
h. [**Wylie Metals**]

2. Source Limitations: Obtain copper and copper alloy decorative metal railing components from single source from single manufacturer.

B. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness of not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars, and of not less than Temper H55 (light drawn) for tube and pipe.

C. Bronze Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).

D. Brass Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).

E. Nickel Silver Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.

F. Bronze Seamless Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).

G. Bronze Seamless Tube: ASTM B135/B135M, Alloy UNS C23000 (red brass, 85 percent copper).

H. Brass Seamless Tube: ASTM B135/B135M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

I. Copper Seamless Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high residual phosphorous copper).

J. Bronze Castings: [**Composition bronze castings complying with ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)**][**or**][**sand castings complying with ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)**].

K. Brass Castings: Sand castings complying with ASTM B584, Alloy UNS C85200 (high-copper yellow brass).

L. Copper Castings: ASTM B824, with a minimum of 99.9 percent copper.

M. Nickel Silver Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).

N. Bronze Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

O. Brass Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

P. Copper Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

Q. Stainless Steel Cable and Cable Fittings for Copper-Alloy Decorative Railings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Bergen Cable Technology, LLC**]
b. [**Carl Stahl DecorCable, Inc.**]
c. [**Esmet, Inc.**]
d. [**Feeney Inc.**]
e. [**Hayn Enterprises, LLC**]
f. [**Johnson, C. Sherman, Co., Inc**]
g. [**Loos & Co. Inc.**]
h. [**Morse Industries**]
i. [**Ronstan International Inc**]
j. [**Seco South, Inc.**]
k. [**Ultra-tec; The Cable Connection**]
l. [**VIVA Railings, LLC**]

2. Cable: [**1-by-19**][**7-by-7**][**7-by-19**] wire cable made from wire complying with ASTM A492, Type 316[**, PVC jacketed**].
3. Cable Diameter: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4 inch (6.4 mm)**].
4. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.
5. Intermediate Cable Supports: Stainless steel flat bar, **1/4-by-1-inch (6.4-by-25.4-mm)**, predrilled.

2.5 STAINLESS STEEL DECORATIVE RAILINGS

A. Stainless Steel Decorative Railings:

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

a. [**AGS Stainless Inc.**]
b. [**Architectural Iron Designs, Inc.**]
c. [**Atlantis Rail Systems**]
d. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
e. [**CraneVeyor Corp**]
f. [**Greco; CSW Industrials Inc.**]
g. [**HDI Railings**]
h. [**Hollaender Architectural Railing Systems; Hollaender Mfg. Co.**]
i. [**Hollaender Mfg. Co.**]
j. [**Julius Blum & Co., Inc.**]
k. [**Kane Innovations, Inc.**]
l. [**Lavi Industries**]
m. [**Livers Bronze Co.**]
n. [**Morse Industries**]
o. [**P&P Artec, Inc.**]
p. [**Seco South, Inc.**]
q. [**Trex Commercial Products, Inc.**]
r. [**Tri Tech, Inc.**]
s. [**Tuttle, a Dant Clayton Division**]

t. [**VIVA Railings, LLC**]
u. [**Wagner Companies (The); R&B Wagner, Inc.**]
v. [**Wylie Metals**]

2. Source Limitations: Obtain stainless steel decorative railing components from single source from single manufacturer.

B. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**][**Grade MT 316L**].

C. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316**][**Grade TP 316L**].

D. Castings: ASTM A743/A743M, [**Grade CF 8 or CF 20**][**Grade CF 8M or CF 3M**].

E. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

F. Flat Bar: ASTM A666, [**Type 304**][**Type 316**][**Type 316L**].

G. Bars and Shapes: ASTM A276/A276M, [**Type 304**][**Type 316**][**Type 316L**].

H. Illuminated [**Top**][**Hand**] Rails: Provide internal illumination using concealed, internally wired, integrated LED [**dimmable**] lamps to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service.

1. LED Luminaires: Comply with [**Section 265119 "LED Interior Lighting"**][**Section 265619 "LED Exterior Lighting"**] and as follows:

a. Lamp Type: [**Linear**][**Point**].
b. Light Illumination: White, [**standard**][**high**] output; [**80 lumens/300 mm**][**120 lumens/300 mm**][**270 lumens/300 mm**].
c. Efficacy: Minimum [**80**] lm/W.
d. Color Rendering Index: Minimum [**65**][**70**][**80**].
e. Correlated Color Temperature: [**2700 K**][**3000 K**][**3500 K**].
f. Rated Lamp Life: [**50,000**] hours at 70 percent lamp illumination output.
g. Beam Distribution: [**Symmetric**][**Asymmetric**][**10 degrees**][**25 degrees**][**55 degrees**][**100 degrees**].
h. LED Diffuser: UV-stabilized acrylic, [**clear**][**translucent**], matching rail profile.
i. Nominal Operating Voltage: [**120 V ac**][**277 V ac**] input; [**12 V dc**][**24 V dc**] output.
j. Internal Driver: [**100**][**120**] W.
k. UL Listing: [**Damp**][**Dry**].
l. IP Rating: IP67.
m. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Stainless Steel Cable and Cable Fittings for Stainless Steel Decorative Railings:

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

a. [**AGS Stainless Inc.**]
b. [**Bergen Cable Technology, LLC**]
c. [**Carl Stahl DecorCable, Inc.**]
d. [**Esmet, Inc.**]
e. [**Feeney Inc.**]

f. [**Hayn Enterprises, LLC**]
g. [**HDI Railings**]
h. [**Johnson, C. Sherman, Co., Inc**]
i. [**Loos & Co. Inc.**]
j. [**Morse Industries**]
k. [**Ronstan International Inc**]
l. [**Seco South, Inc.**]
m. [**Trex Commercial Products, Inc.**]
n. [**Ultra-tec; The Cable Connection**]
o. [**VIVA Railings, LLC**]

2. Cable: [**1-by-19**][**7-by-7**][**7-by-19**] wire cable made from wire complying with ASTM A492, Type 316[**, PVC jacketed**].
3. Cable Diameter: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4 inch (6.4 mm)**].
4. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.
5. Intermediate Cable Supports: Stainless steel flat bar, **1/4-by-1-inch (6.4-by-25.4-mm)**, predrilled.

J. Expanded Metal Infill Panels: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**], Class 3 (corrosion-resisting steel), made from stainless steel sheet complying with ASTM A666, [**Type 304**][**Type 316**].

1. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

K. Perforated Metal Infill Panels: Stainless steel sheet, ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316L**], [**0.062 inch (1.59 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].

L. Woven-Wire Mesh Infill Panels: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.135-inch (3.5-mm)** nominal diameter stainless steel wire complying with ASTM A580/A580M, [**Type 304**][**Type 316**].

2.6 STEEL AND IRON DECORATIVE RAILINGS

A. Steel and Iron Decorative Railings:

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

a. [**Architectural Iron Designs, Inc.**]
b. [**HDI Railings**]
c. [**Indital USA**]
d. [**Lawler Foundry Corporation**]
e. [**Livers Bronze Co.**]
f. [**Olin Metal Works**]
g. [**Regency Railings**]
h. [**Trex Commercial Products, Inc.**]
i. [**Tri Tech, Inc.**]

j. [**VIVA Railings, LLC**]
k. [**Wagner Companies (The); R&B Wagner, Inc.**]
l. [**Wiemann Metalcraft**]

2. Source Limitations: Obtain steel decorative railing components from single source from single manufacturer.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M, Type 5**].

D. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

E. Plates, Shapes, and Bars: ASTM A36/A36M.

F. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

G. Illuminated [**Top**][**Hand**] Rails: Provide internal illumination using concealed, internally wired, integrated LED [**dimmable**] lamps to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service.

1. LED Luminaires: Comply with [**Section 265119 "LED Interior Lighting"**][**Section 265619 "LED Exterior Lighting"**] and as follows:

a. Lamp Type: [**Linear**][**Point**].
b. Light Illumination: White, [**standard**][**high**] output; [**80 lumens/300 mm**][**120 lumens/300 mm**][**270 lumens/300 mm**].
c. Efficacy: Minimum [**80**] lm/W.
d. Color Rendering Index: Minimum [**65**][**70**][**80**].
e. Correlated Color Temperature: [**2700 K**][**3000 K**][**3500 K**].
f. Rated Lamp Life: [**50,000**] hours at 70 percent lamp illumination output.
g. Beam Distribution: [**Symmetric**][**Asymmetric**][**10 degrees**][**25 degrees**][**55 degrees**][**100 degrees**].
h. LED Diffuser: UV-stabilized acrylic, [**clear**][**translucent**], matching rail profile.
i. Nominal Operating Voltage: [**120 V ac**][**277 V ac**] input; [**12 V dc**][**24 V dc**] output.
j. Internal Driver: [**100**][**120**] W.
k. UL Listing: [**Damp**][**Dry**].
l. IP Rating: IP67.
m. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Stainless Steel Cable and Cable Fittings for Steel and Iron Decorative Railings:

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

a. [**Bergen Cable Technology, LLC**]
b. [**Carl Stahl DecorCable, Inc.**]
c. [**Esmet, Inc.**]
d. [**Feeney Inc.**]
e. [**Hayn Enterprises, LLC**]

f. [**Johnson, C. Sherman, Co., Inc**]
g. [**Loos & Co. Inc.**]
h. [**Morse Industries**]
i. [**Ronstan International Inc**]
j. [**Seco South, Inc.**]
k. [**Ultra-tec; The Cable Connection**]
l. [**VIVA Railings, LLC**]

2. Cable: [**1-by-19**][**7-by-7**][**7-by-19**] wire cable made from wire complying with ASTM A492, Type 316[**, PVC jacketed**].
3. Cable Diameter: [**1/8 inch (3.2 mm)**][**5/32 inch (4 mm)**][**3/16 inch (5 mm)**][**1/4 inch (6.4 mm)**].
4. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.
5. Intermediate Cable Supports: Stainless steel flat bar, **1/4-by-1-inch (6.4-by-25.4-mm)**, predrilled.

I. Expanded Metal Infill Panels: ASTM F1267, [**Type I (expanded)**][**Type II (expanded and flattened)**], Class 1 (uncoated).

1. Style Designation: [**3/4 number 13**][**1-1/2 number 10**].

J. Perforated Metal Infill Panels:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel Type B, [**0.060 inch (1.52 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**].
2. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, commercial steel Type B, [**0.064 inch (1.63 mm)**] thick, [**with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows**][**with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows**].

K. Woven-Wire Mesh Infill Panels: Intermediate-crimp, [**diamond**][**square**] pattern, **2-inch (50-mm)** woven-wire mesh, made from **0.135-inch (3.5-mm)** nominal diameter steel wire complying with ASTM A510/A510M.

2.7 FASTENERS

A. Fastener Materials:

1. Aluminum Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.
2. Copper-Alloy (Bronze) Railing Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed; muntz metal (Alloy 280) fasteners where exposed**].
3. Copper-Alloy (Brass) Railing Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed; brass (Alloy 260 or Alloy 360) fasteners where exposed**].
4. Stainless Steel Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.
5. Ungalvanized-Steel Railing Components: Plated-steel fasteners complying with ASTM F1941/F1941M, Class Fe/Zn 5 for electrodeposited zinc coating where concealed; Type 304 stainless steel fasteners where exposed.
6. Hot-Dip Galvanized-Steel Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
7. Dissimilar Metal Railing Components: [**Type 304**][**Type 316**] stainless steel fasteners.
8. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction[**and capable of withstanding design loads**].

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable**][**exposed fasteners are the standard fastening method for railings indicated**].

1. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593 and nuts, ASTM F594.

2.8 MISCELLANEOUS MATERIALS

A. Handrail Brackets: [**Cast-aluminum,**][**Cast-bronze,**][**Cast-brass,**][**Cast-copper,**][**Cast-nickel-silver,**][**Cast stainless steel,**][**Cast-iron**] center of handrail [**2-1/2 inches (63.5 mm)**][**3-1/8 inches (79.4 mm)**] from [**face of railing**][**wall**].

1. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
2. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
3. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.
4. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.

B. Wood Rails:

1. Clear, straight-grained hardwood rails secured to [**recessed**][**exposed**] metal subrail.

a. Species: [**Ash**][**Cherry**][**Red oak**][**Teak**][**Walnut**][**White oak**].
b. Finish: [**Manufacturer's standard**][**Transparent polyurethane**][**Penetrating oil**][**Acrylic impregnated**].
c. Staining: [**None**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].
d. Profile: [**Square, 1-3/4 by 1-3/4 inches (45 by 45 mm) with edges eased to 1/4-inch (6-mm) radius**][**Rectangular, 1-3/4 by 5 inches (45 by 127 mm) with edges eased to 1/4-inch (6-mm) radius**][**Round, 2-inch (50-mm) diameter**][**As indicated on Drawings**].

2. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
3. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
4. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
5. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**]

certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

6. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
7. Hardwood rails complying with Section 064023 "Interior Architectural Woodwork."

C. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For [**aluminum**][**and**][**stainless steel**] railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

D. Brazing Rods: For copper-alloy railings, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

E. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.

F. Etching Cleaner for Galvanized Metal: Compatible with coating system specified.

G. Galvanizing Repair Paint: High-zinc-dust-content paint compatible with coating system specified.

H. Shop Primers: Provide primers that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

I. Epoxy Zinc-Rich Primer: Compatible with topcoat.

J. Shop Primer for Galvanized Steel: [**Cementitious galvanized metal primer**][**Vinyl wash primer**][**Water-based galvanized metal primer**].

K. Intermediate Coats and Topcoats: Provide products that comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

L. Epoxy Intermediate Coat: Compatible with primer and topcoat.

M. Polyurethane Topcoat: Compatible with undercoat.

N. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

O. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

P. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: [**At exterior locations**][**and**][**where indicated on Drawings**], provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.9 FABRICATION

A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage[**, but not less than that required to support structural loads**].

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.

1. Clearly mark units for reassembly and coordinated installation.
2. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water.

1. Provide weep holes where water may accumulate.
2. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with [**welded**][**or**][**mechanical**] connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.

I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

J. Brazed Connections: Connect copper and copper-alloy railings by brazing. Cope components at connections to provide close fit, or use fittings designed for this purpose. Braze corners and seams continuously.

1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
2. Remove flux immediately.
3. At exposed connections, finish exposed surfaces smooth and blended, so no roughness shows after finishing and brazed surface matches contours of adjoining surfaces.

K. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings.

1. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

2. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

L. Form changes in direction as follows:

1. As detailed.
2. [**By bending**][**or**][**by inserting prefabricated elbow fittings**].
3. [**By flush bends**][**or**][**by inserting prefabricated flush-elbow fittings**].
4. [**By radius bends of radius indicated**][**or**][**by inserting prefabricated elbow fittings of radius indicated**].
5. By bending to smallest radius that will not result in distortion of railing member.

M. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

N. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

O. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.

P. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other Work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.

Q. Provide inserts and other anchorage devices for connecting railings to concrete or masonry Work.

1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
2. Coordinate anchorage devices with supporting structure.

R. For railing posts set in concrete, provide stainless steel sleeves not less than **6 inches (150 mm)** long with inside dimensions not less than **1/2 inch (13 mm)** greater than outside dimensions of post, with metal plate forming bottom closure.

S. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.

1. Provide socket covers designed and fabricated to resist being dislodged.
2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

T. Stainless Steel Cable Guard Infill: Fabricate cable guard infill assemblies in the shop to field-measured dimensions with fittings machine swaged.

1. Minimize amount of turnbuckle take-up used for dimensional adjustment, so maximum amount is available for tensioning cable.
2. Tag cable assemblies and fittings to identify installation locations and orientations for coordinated installation.

U. Expanded-Metal Infill Panels: Fabricate infill panels from [**aluminum**][**stainless steel**][**steel**] expanded-metal sheet[**unless otherwise indicated**].

1. Edge panels with U-shaped channels made from same metal as infill; not less than **0.043 inch (1.1 mm)** thick.
2. Orient expanded metal with long dimension of diamonds [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**].

V. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from [**aluminum**][**stainless steel**][**steel**][**galvanized steel**][**same metal as railings in which they are installed**].

1. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than **0.043 inch (1.1 mm)** thick.
2. Orient perforated metal with pattern [**parallel to top rail**][**perpendicular to top rail**][**horizontal**][**vertical**].

W. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into **1-by-1/2-by-1/8-inch (25-by-13-by-3-mm)** metal channel frames.

1. Fabricate wire mesh and frames from [**aluminum**][**stainless steel**][**steel**][**unless otherwise indicated**].
2. Orient wire mesh with [**diamonds vertical**][**wires perpendicular and parallel to top rail**][**wires horizontal and vertical**].

X. Toe Boards: Where indicated on Drawings, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.10 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.11 ALUMINUM FINISHES

A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34,**

Class II, 0.010 mm] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Organic Finish, Two-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Superior-Performing Organic Finish, Three-Coat (Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. Superior-Performing Organic Finish, Four-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performing Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605, containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

J. Superior-Performing Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605, containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and

apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.12 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

B. Buffed Finish: M21 (Mechanical Finish: Buffed, smooth specular).

C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: Directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).

D. Medium-Satin Finish: M32 (Mechanical Finish: Directionally textured, medium satin).

E. Fine-Matte Finish: M42 (Mechanical Finish: Nondirectional finish, fine matte).

F. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: Buffed, smooth specular; Coating: Clear organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats in accordance with manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: Directionally textured, fine satin; Mechanical Finish: Directionally textured, hand rubbed; Coating: Clear organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats in accordance with manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: Directionally textured, medium satin; Coating: Clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats in accordance with manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

I. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: Nondirectional finish, fine matte; Coating: Clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats in accordance with manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: Directionally textured, fine satin; Chemical Finish: Conversion coating, sulfide)[**, with color matching Architect's sample**].

K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: Directionally textured, uniform; Chemical Finish: Nonetched cleaned, degreased; Chemical Finish: Conversion coating, ammonium sulfate)[**, with**

color matching Architect's sample].

2.13 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces.
3. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirrorlike finish**][**to match Architect's sample**].

D. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.
2. High-Luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

2.14 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize[**exterior**] steel and iron railings, including hardware, after fabrication.
2. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
3. Comply with ASTM A123/A123M for hot-dip galvanized railings.
4. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
5. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
6. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner[**and as follows:**]

1. Comply with SSPC-SP 16.

D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.

E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [**SSPC-SP 6/NACE No. 3.**][**SSPC-SP 7/NACE No. 4.**][**requirements indicated below:**]

1. Exterior Railings: SSPC-SP 6/NACE No. 3.

2. Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.
3. Railings Indicated To Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
4. Other Railings: SSPC-SP 7/NACE No. 4.

F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated railings with [**primers specified in Section 099113 "Exterior Painting"**][**primers specified in Section 099123 "Interior Painting"**] unless [**zinc-rich primer is**][**primers specified in Section 099600 "High-Performance Coatings" are**] indicated.
2. Do not apply primer to galvanized surfaces.

G. Shop-Painted Finish: Comply with [**Section 099113 "Exterior Painting."**][**Section 099600 "High-Performance Coatings."**]

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Powder-Coat Finish for Uncoated Ferrous Metal: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3.
2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness of not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

J. Powder-Coat Finish for Galvanized Metal: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness of not less than **1.5 mils (0.04 mm)**.
4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Perform cutting, drilling, and fitting required for installing railings.

1. Fit exposed connections together to form tight, hairline joints.
2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
5. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3 m)**.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of [**aluminum**][**and**][**copper alloys**] that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending **2 inches (50 mm)** beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within **6 inches (150 mm)** of post.

3.4 ANCHORING POSTS

A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than **5 inches (125 mm)** deep and **3/4 inch (20 mm)** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, [**welded to post after placing anchoring material**][**attached to post with setscrews**].

D. Leave anchorage joint exposed with [**1/8-inch (3-mm) buildup, sloped away from post**][**anchoring material flush with adjacent surface**].

E. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For aluminum railings, attach posts as indicated, using fittings designed and engineered for this purpose.
2. For copper-alloy railings, attach posts as indicated, using fittings designed and engineered for this purpose.
3. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
4. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

A. Anchor railing ends to concrete and masonry with [**sleeves concealed within**][**flanges connected to**][**brackets on underside of rails connected to**] railing ends and anchored to wall construction with anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and [**welded to railing ends**][**or**][**connected to railing ends, using nonwelded connections**].

C. Attach handrails to walls with wall brackets[**, except where end flanges are used**]. Provide brackets with [**1-1/2-inch (38-mm)**] clearance from inside face of handrail and finished wall surface.

1. Use type of bracket with [**flange tapped for concealed anchorage to threaded hanger bolt**][**predrilled hole for exposed bolt anchorage**].
2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets[**and railing end flanges**] to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into[**fire-retardant-treated**] wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.
6. For steel-framed partitions, fasten brackets with toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with

SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

3.7 FIELD QUALITY CONTROL

A. Testing Agency: the Owner will engage a qualified testing agency to perform tests and inspections and to prepare test reports. Payment for these services will be made [the Owner][**from the testing and inspecting allowance, as authorized by Change Orders**].

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894 and ASTM E935 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory, as directed by the Owner.

D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.8 CLEANING

A. Clean [**aluminum**][**and**][**stainless steel**] by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

B. Clean copper alloys in accordance with metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Clean [**wood rails**][**and**][**plastic handrail caps**] by wiping with a damp cloth and then wiping dry.

D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

3.9 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00 00

SECTION 05 73 00 00A - GLAZED DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glazed decorative metal railings.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring railings.

1.2 DEFINITIONS

A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor and exterior deck areas and for pedestrian guidance and support, visual separation, or wall protection.

1.3 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

A. Product Data:

1. Metal railings assembled from standard components.
2. Glass products.
3. Glazing cement and accessories for structural glass railings.
4. Sealant and accessories for structural glass railings.
5. Fasteners.
6. Wood rails.
7. Lacquer for copper alloys.
8. Shop primer.
9. Bituminous paint.
10. Nonshrink, nonmetallic grout.
11. Anchoring cement.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

C. Shop Drawings: Include plans, elevations, sections, and attachment details.

D. Samples for Initial Selection: For products involving selection of color, texture, or design[**, including mechanical finishes**].

E. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Base channel.
3. Each type of glass and glass edge required.
4. Fittings and brackets.
5. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, [**structural glass balusters,**][**and**][**glass-infill panels**]. Show method of finishing members at intersections. Samples need not be full height.

F. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**professional engineer**][**testing agency**].

B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

C. Product Test Reports: For tests performed by a qualified testing agency, in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.

D. Evaluation Reports: From ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1. For glazed decorative metal railings.
2. For post-installed anchors.

E. Preconstruction test reports.

1.7 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups as indicated on Drawings.
2. Build mockups for each form and finish of glass-infill panel railing consisting of two posts, top rail, handrail, glass-infill panel, and anchorage system components that are full height and are not less than **24 inches (600 mm)** in length.
3. Build mockups for each form and finish of structural glass railing consisting of top rail, structural glass, base channel, and anchorage system components that are full height and are not less than **24 inches (600 mm)** in length.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made [**as directed by the Owner**][**from the testing and inspecting allowance, as authorized by Change Orders**][**by Contractor**]. Retesting of products that fail to meet specified requirements is to be done at Contractor's expense.

1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
2. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.
3. Notify Architect [**seven**] days in advance of the dates and times when laboratory mockups will be tested, as directed by the Owner.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Laminated Glass: Glazed decorative metal railing manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: [**Five**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazed decorative metal railings, including attachment to building construction.

B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Aluminum: The lesser of minimum yield strength divided by 1.65, or minimum ultimate tensile strength divided by 1.95.
2. Copper Alloys: 60 percent of minimum yield strength.
3. Stainless Steel: 60 percent of minimum yield strength.
4. Steel: 72 percent of minimum yield strength.
5. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA CW-12, "Structural Properties of Glass."

C. Structural Performance: Railings, including attachment to building construction, are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

   a. Uniform load of **50 lbf/ft. (0.73 kN/m)** applied in any direction.
   b. Concentrated load of **200 lbf (0.89 kN)** applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Structural Glass Railings and Glass-Infill Panels:

   a. Concentrated load of **50 lbf (0.22 kN)** applied horizontally on an area of **1 sq. ft. (0.093 sq. m)**.
   b. Infill load and other loads need not be assumed to act concurrently.

3. For structural glass railings, support each section of top rail [**and handrail**]by a minimum of three glass panels or by other means so railings will remain in place if any one glass panel fails.

   a. Support top rail [**and handrail**]ends such that railings remains in place if end glass panel fails.

D. Wind Loads: For exterior glazed decorative metal railings, capable of withstanding the following wind loads in accordance with the IBC and ASTM E1300:

1. Wind Load: [**As indicated on Drawings**].

E. Windborne-Debris-Impact Resistance: Exterior glazed decorative metal railings passing ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**][**2**][**3**][**4**] for [**basic**][**enhanced**] protection.

1. Large-Missile Test: For exterior glazing located within [**30 feet (9.1 m)**] of grade.
2. Small-Missile Test: For exterior glazing located between **30 feet (9.1 m)** and [**60 feet (18.3 m)**] above grade.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 GLAZED DECORATIVE METAL RAILINGS

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

1. [**ATR Technologies, Inc.**]
2. [**C.R. Laurence Co., Inc.; CRH Americas, Inc.**]
3. [**CraneVeyor Corp**]
4. [**Glass Vice USA**]
5. [**Greco; CSW Industrials Inc.**]
6. [**Hollaender Architectural Railing Systems; Hollaender Mfg. Co.**]
7. [**Hollaender Mfg. Co.**]
8. [**Julius Blum & Co., Inc.**]
9. [**Livers Bronze Co.**]
10. [**Morse Industries**]
11. [**Southwest Metalsmiths, Inc.**]
12. [**TACO Metals Inc.**]

13. [**Trex Commercial Products, Inc.**]
14. [**Tri Tech, Inc.**]
15. [**Tuttle, a Dant Clayton Division**]
16. [**VIVA Railings, LLC**]
17. [**Wagner Companies (The); R&B Wagner, Inc.**]

B. Source Limitations for Laminated Glass: Obtain from single source from single manufacturer.

C. Source Limitations for Decorative Metal Railing Components: Obtain from single source from single manufacturer for each component and installation method.

D. Product Options: Information on Drawings and in the Specifications establishes requirements for railing system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.4 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

B. Extruded Bars and Shapes, Including Extruded Tube: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5/T52.

C. Extruded Structural Pipe and Round Tube: ASTM B429/B429M, Alloy 6063-T6.

1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

D. Drawn Seamless Tubing: **ASTM B210 (ASTM B210M)**, Alloy 6063-T832.

E. Plate and Sheet: **ASTM B209 (ASTM B209M)**, [**Alloy 5005-H32**][**Alloy 6061-T6**].

F. Die and Hand Forgings: **ASTM B247 (ASTM B247M)**, Alloy 6061-T6.

G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.5 STAINLESS STEEL

A. Tubing: ASTM A554, [**Grade MT 304**][**Grade MT 316**].

B. Pipe: ASTM A312/A312M, [**Grade TP 304**][**Grade TP 316**].

C. Castings: ASTM A743/A743M, [**Grade CF 8 or Grade CF 20**][**Grade CF 8M or Grade CF 3M**].

D. Sheet, Strip, Plate, and Flat Bar: ASTM A666 or ASTM A240/A240M, [**Type 304**][**Type 316**].

E. Bars and Shapes: ASTM A276, [**Type 304**][**Type 316**].

2.6 STEEL AND IRON

A. Tubing: [**ASTM A500/A500M (cold formed)**][**or**][**ASTM A513/A513M**].

B. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

2.7 COPPER ALLOYS

A. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars and Temper H55 (light drawn) for tube and pipe.

B. Bronze Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).

C. Brass Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).

D. Nickel Silver Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.

E. Bronze Seamless Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).

F. Bronze Seamless Tube: ASTM B135/B135M Alloy UNS C23000 (red brass, 85 percent copper).

G. Brass Seamless Tube: ASTM B135/B135M Alloy UNS C26000 (cartridge brass, 70 percent copper).

H. Copper Seamless Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

I. Bronze Castings: [**Composition bronze castings complying with ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)**][**or**][**sand castings complying with ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)**].

J. Brass Castings: Sand castings complying with ASTM B584, Alloy UNS C85200 (high-copper yellow brass).

K. Copper Castings: ASTM B824, with a minimum of 99.9 percent copper.

L. Nickel Silver Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).

M. Bronze Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

N. Brass Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

O. Copper Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

2.8 GLASS AND GLAZING PRODUCTS, GENERAL

A. Glazing Publications: Comply with written instructions of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA/GANA Publications: [**"GANA Laminated Glazing Reference Manual" and**]"GANA Glazing Manual."

B. Safety Glazing: Glazing is to comply with 16 CFR 1201, Category II.

C. Safety Glazing Labeling: Permanently mark glass with certification label of [**the SGCC**][**the SGCC or another certification agency acceptable to authorities having jurisdiction**][**or**][**manufacturer**]. Label is to indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

D. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

E. Low-Iron Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.

F. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.

G. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Class 1 and low-iron clear, or Class 2 (tinted) as indicated, Quality-Q3.

H. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

I. Ceramic-Coated Glass: Heat-strengthened float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual" and with other requirements specified.

J. Bent Glass: ASTM C1464, [**Kind BFT (bent, tempered)**][**Kind BHS, (bent, heat strengthened)**][**Kind BL, (bent, laminated)**].

K. Glazing Cement and Accessories for Structural Glass Railings: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.

L. Sealant and Accessories for Structural Glass Railings: Sealant, gaskets, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.

M. Glazing Gaskets for Glass-Infill Panels: Glazing gaskets and related accessories as recommended or supplied by railing manufacturer for installing glass-infill panels in post-supported railings.

2.9 GLASS HANDRAILS AND GUARDS

A. Tempered Glass Handrails and Guards: Provide products that have been tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.

1. Glass Color: [**Clear**][**Blue**][**Blue-green**][**Bronze**][**Green**][**Gray**].
2. Thickness for Structural Glass Balusters: As required by structural loads, but not less than [**12.0**][**19.0**] mm.
3. Thickness for Glass-Infill Panels: As required by structural loads, but not less than [**6.0**][**10.0**] mm.
4. Glass Thickness: As indicated on Drawings.

B. Laminated Glass Handrails and Guards: ASTM C1172, Type II with two plies of glass bonded together by an interlayer.

1. Construction: Laminate glass with [**polyvinyl butyral interlayer**][**or**][**ionoplast polymer interlayer**] to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: [**0.030 inch (0.76 mm)**][**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Kind: [**LHS (laminated heat strengthened)**][**LT (laminated tempered)**][**As indicated**].
4. Glass Color: Inner-ply [**clear**][**low-iron clear**][**blue**][**blue-green**][**bronze**][**green**][**gray**]; outer-ply [**clear**][**low-iron clear**][**blue**][**blue-green**][**bronze**][**green**][**gray**].
5. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**], applied to [**inner**][**outer**] glass ply.
6. Interlayer Color: [**Clear**][**Blue-green**][**Bronze light**][**Gray**].
7. Interlayer Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match**][**Provide**].
8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than [**6.0**][**8.0**] mm thick each.
9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than [**3.0**][**4.0**][**5.0**] mm each.

C. Windborne-Debris-Impact-Resistant Laminated Glass Guards: ASTM C1172, Type II with two plies of glass bonded together with an interlayer.

1. Construction: Laminate glass with [**polyvinyl butyral interlayer**][**or**][**ionoplast polymer interlayer**] to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: [**0.060 inch (1.52 mm)**][**0.090 inch (2.29 mm)**].
3. Kind: [**LHS (laminated heat strengthened)**][**LT (laminated tempered)**][**As indicated**].
4. Glass Color: Inner-ply [**clear**][**low-iron clear**][**blue**][**blue-green**][**bronze**][**green**][**gray**]; outer-ply [**clear**][**low-iron clear**][**blue**][**blue-green**][**bronze**][**green**][**gray**].
5. Ceramic Coating Color and Pattern: [**As selected by Architect from manufacturer's full range**] applied to [**inner**][**outer**] glass ply.
6. Interlayer Color: [**Clear**][**Blue-green**][**Bronze light**][**Gray**].
7. Interlayer Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match**][**Provide**].
8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than [**6.0**][**8.0**][**10**] mm thick each.
9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than [**4.0**][**5.0**] mm each.

2.10 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:

1. Aluminum Components: [**Type 304**][**Type 316**] stainless steel fasteners.
2. Stainless Steel Components: [**Type 304**][**Type 316**] stainless steel fasteners.
3. Copper-Alloy (Bronze) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed; muntz metal (Alloy 280) fasteners where exposed**].
4. Copper-Alloy (Brass) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners[**where concealed; brass (Alloy 260 or Alloy 360) fasteners where exposed**].

5. Dissimilar Metals: [**Type 304**][**Type 316**] stainless steel fasteners.

B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated[**and capable of withstanding design loads**].

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable**][**exposed fasteners are the standard fastening method for railings indicated**].

1. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts; **ASTM F594 (ASTM F836M)**.

2.11 MISCELLANEOUS MATERIALS

A. Handrail Brackets: [**Cast aluminum,**][**Cast stainless steel,**][**Cast bronze,**][**Cast brass,**][**Cast copper,**][**Cast nickel-silver,**] center of rail [**2-1/2 inches (63.5 mm)**][**3-1/8 inches (79.4 mm)**] from face of structural glass balusters.

B. Wood Rails:

1. Clear, straight-grained hardwood rails secured to [**recessed**][**exposed**] metal subrail.

a. Species: [**Ash**][**Cherry**][**Red oak**][**Walnut**][**White oak**].
b. Finish: [**Manufacturer's standard**][**Transparent polyurethane**][**Penetrating oil**][**Acrylic impregnated**].
c. Staining: [**None**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].
d. Profile: [**Square, 1-3/4 by 1-3/4 inches (45 by 45 mm) with edges eased to 1/4-inch (6-mm) radius**][**Rectangular, 1-3/4 by 5 inches (45 by 127 mm) with edges eased to 1/4-inch (6-mm) radius**][**Round, 2-inch (50-mm) diameter**][**As indicated**].

2. Hardwood rails complying with Section 064023 "Interior Architectural Woodwork."
3. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
4. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
5. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
6. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

7. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

C. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.

D. Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Anchoring Cement: [**At exterior locations**][**and**][**where indicated**] provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.12 FABRICATION OF METAL RAILINGS

A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage[**, but not less than that required to support structural loads**].

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

H. Form changes in direction as follows:

1. As detailed.

2. [**By bending**][**or**][**by inserting prefabricated elbow fittings**].
3. [**By flush bends**][**or**][**by inserting prefabricated flush-elbow fittings**].
4. [**By radius bends of radius indicated**][**or**][**by inserting prefabricated elbow fittings of radius indicated**].
5. By bending to smallest radius that will not result in distortion of railing member.

I. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

J. Close exposed ends of hollow railing members with prefabricated end fittings.

K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other work where indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.

L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

M. For railing posts set in concrete, provide [**steel**][**stainless steel**] sleeves not less than **6 inches (150 mm)** long with inside dimensions not less than **1/2 inch (13 mm)** greater than outside dimensions of post, with metal plate forming bottom closure.

2.13 FABRICATION OF GLASS PANELS AND BALUSTERS

A. Fabricate glass to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

B. Glass-Infill Panels: Provide [**tempered**][**laminated, heat-strengthened**][**laminated, tempered**] glass-infill panels[**for both straight and curved sections**].

1. Edge Finish: [**Clean-cut or flat-grind edges to produce smooth, square edges with slight chamfers at junctions of edges and faces**].

C. Structural Glass Balusters: Provide [**tempered**][**laminated, heat-strengthened**][**laminated, tempered**] structural glass balusters[**for both straight and curved sections**].

1. Edge Finish: [**Grind smooth and flat polish exposed edges of glass, including those at open joints, to produce smooth, square edges with glass edge finishes**].
2. Factory-bond structural glass balusters to aluminum base and top-rail channels in railing manufacturer's plant using [**glazing cement**][**sealant**] to comply with manufacturer's written instructions[**, unless field glazing is standard with manufacturer**].
3. Fabricate structural glass balusters to maintain equal length glass widths and uniform spacing of [**1/2 inch (13 mm)**] between glass balusters.

2.14 METAL FINISH REQUIREMENTS, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.15 ALUMINUM FINISHES

A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**][**AAMA 2605**] and containing not less than [**50**][**70**] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Superior-Performing Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. Superior-Performing Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performing Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

J. Superior-Performing Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.16 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing [**to a high luster finish**][**to a mirrorlike finish**][**to match Architect's sample**].

D. Stainless Steel Sheet, Strip, Plate, and Bar Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.
2. High Luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

2.17 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system for designating copper-alloy finish systems defined in NAAMM/NOMMA 500, "Metal Finishes Manual for Architectural and Metal Products."

B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).

D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).

F. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

G. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

H. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

I. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide.

1. Color: Match Architect's sample, as directed by the Owner.

K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate)[**, with color matching Architect's sample**], as directed by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Drawings and manufacturer's written instructions for installing glazed decorative metal railings, accessories, and other components.

B. Windborne-Debris Resistance: Anchor glazed decorative metal railings to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris-resistance testing.

C. Perform cutting, drilling, and fitting required for installing metal railings.

1. Fit exposed connections together to form tight, hairline joints.

2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of metal railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
5. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet (5 mm in 3 m)**.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of [**aluminum**][**and**][**copper alloys**] that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with [**shop primer**][**bituminous paint**].

E. Adjust railings before anchoring to ensure matching alignment at abutting joints.

F. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 METAL RAILING CONNECTIONS

A. Nonwelded Connections:

1. Use mechanical or adhesive joints for permanently connecting railing components.
2. Use wood blocks and padding to prevent damage to railing members and fittings.
3. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Expansion Joints: Install expansion joints at locations indicated, but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending **2 inches (50 mm)** beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within **6 inches (150 mm)** of post.

3.3 METAL ANCHORING POSTS

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted in sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than **5 inches (125 mm)** deep and **3/4 inch (20 mm)** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, [**welded to post after placing anchoring material**][**attached to post with setscrews**].

D. Leave anchorage joint exposed with [**1/8-inch (3-mm) buildup, sloped away from post**][**anchoring material flush with adjacent surface**].

E. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions,

connected to posts and to metal supporting members as follows:

1. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
2. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
3. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.4 INSTALLATION OF GLASS BALUSTERS

A. Structural Glass Railings:

1. Install assembly to comply with railing manufacturer's written instructions.
2. Attach base channel to building structure, then insert and connect factory-fabricated and -assembled glass balusters[**if glass was bonded to base and top-rail channels in factory**].
3. For field-assembled balusters, attach base channel to building structure, insert glass in base channel, and bond with [**glazing cement**][**sealant**].

    a. Support glass balusters in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement.
    b. Fill remaining space in base channel with [**glazing cement**][**sealant**] for uniform support of glass.

4. Adjust spacing of glass balusters so gaps between balusters are equal before securing in position.
5. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.

B. Post-Supported Railings with Glass-Infill Panels:

1. Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles.
2. Erect posts and other metal railing components, and set factory-cut glass-infill panels.
3. Do not cut, drill, or alter glass-infill panels in field. Protect edges from damage.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: the Owner will engage a qualified testing agency to perform tests and inspections and to prepare test reports. Payment for these services will be made [**as directed by the Owner**][**from the testing and inspecting allowance, as authorized by Change Orders**].

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements, as directed by the Owner.

D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced

or additional work with specified requirements.

3.6 CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.

B. Clean copper alloys in accordance with metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

D. Clean wood rails by wiping with a damp cloth and then wiping dry.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00 00A

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Task	Specification	Specification Description
05 73 00 00	05 70 00 00	Decorative Metal
05 73 00 00	05 75 00 00	Decorative Formed Metal
05 73 23 00	05 70 00 00	Decorative Metal
05 73 23 00	05 73 00 00	Decorative Metal Railings
05 73 23 00	05 73 00 00a	Glazed Decorative Metal Railings
05 73 23 00	05 75 00 00	Decorative Formed Metal

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SECTION 05 75 00 00 - DECORATIVE FORMED METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Beam wraps.
2. Closures and trim.
3. Decorative-metal-clad doors and frames.
4. Escalator enclosures.
5. Filler panels.
6. Lighting coves.
7. Metal base.
8. Mullion cladding.
9. Pipe system covers.
10. Pockets for window treatment.
11. Window stools.

B. Related Requirements:

1. Section 057000 "Decorative Metal" for decorative items made primarily from plate, bars, extrusions, tubes, castings, and other forms of metal, but which may include sheet metal components.
2. Section 076100 "Sheet Metal Roofing" for items made of formed metal for roofing.
3. Section 076200 "Sheet Metal Flashing and Trim" for items made of formed metal for flashings and trim.
4. Section 077100 "Roof Specialties" for items made of formed metal for parapets and copings.

1.2 COORDINATION

A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes of deterioration.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show fabrication and installation details for decorative formed metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Samples for Initial Selection: For products involving selection of color, texture, or design[**including mechanical finishes**].

E. Samples for Verification: For each type of exposed finish required, prepared on **6-inch- (150-mm-)** square Samples of metal of same thickness and material indicated for the Work.

F. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.

B. Qualification Data: For [**Installer**][**fabricator**][**organic-coating applicator**][**anodic finisher**][**powder-coating applicator**][**and**][**professional engineer**].

C. Mill Certificates: Signed by stainless steel manufacturers certifying that products furnished comply with requirements.

D. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For [**mirrorlike stainless steel finish**][**and**][**statuary conversion coating copper-alloy finish**] to include in maintenance manuals.

1.7 QUALITY ASSURANCE

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

B. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type

indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Installer Qualifications: Fabricator of products.

F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

B. Store products on elevated platforms in a dry location.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For decorative metal items, obtain each color, grade, finish, type, and variety of metal from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design decorative formed metal, including attachment to building construction.

B. Structural Performance: Decorative formed metal items, including anchors and connections, are to withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

1. Wind Loads on Exterior Items: [**As indicated on Drawings**][**20 lbf/sq. ft. (957 Pa)**][**30 lbf/sq. ft. (1436 Pa)**].

C. Seismic Performance: Exterior decorative formed metal items, including anchors and connections, are

to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

1. Component Importance Factor: 1.0.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.

2.3 SHEET METAL

A. General: Fabricate products from sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] percent.

C. Aluminum Sheet: Flat sheet complying with **ASTM B209 (ASTM B209M)**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties of not less than Alloy 5005-H32.

D. Galvanized-Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, either commercial steel or forming steel.

E. Steel Sheet: [**Uncoated, cold-rolled, ASTM A1008/A1008M, commercial steel, exposed**][**or**][**electrolytic zinc-coated, ASTM A879/A879M, with steel sheet substrate complying with ASTM A1008/A1008M, commercial steel, exposed**].

F. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**], stretcher-leveled standard of flatness.

G. Bronze Sheet: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper) or Alloy UNS C23000 (red brass, 85 percent copper).

H. Brass Sheet: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

I. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper.

J. Titanium Sheet: ASTM B265, Grade 1.

2.4 MISCELLANEOUS MATERIALS

A. Gaskets: As required to seal joints in decorative formed metal and remain [**airtight**][**weathertight**]; as recommended in writing by decorative formed metal manufacturer.

1. ASTM D1056, Type 1, Class A, grade as recommended by gasket manufacturer to obtain seal for application indicated.
2. Closed-cell polyurethane foam, adhesive on two sides, release paper protected.

B. Sealants, Exterior: Elastomeric sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

C. Sealants, Interior: Nonsag, paintable sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

D. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.

1. Use filler metals that will match the color of metal being joined and will not cause discoloration.

E. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless [**otherwise indicated**][**exposed fasteners are unavoidable or are the standard fastening method**].
2. Provide [**Phillips**][**tamper-resistant**][**square or hex socket**] flat-head machine screws for exposed fasteners unless otherwise indicated.

F. Structural Anchors: For applications indicated to comply with certain design loads, provide fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

G. Nonstructural Anchors: For applications not indicated to comply with design loads, provide fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193[**or ICC-ES AC308**].

H. Anchor Materials:

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or **ASTM F1941 (ASTM F1941M)**, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.

I. Sound-Deadening Materials:

1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C665, Type I, and passing ASTM E136 test.
2. Mastic: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

J. Backing Materials: Provided or recommended by decorative formed metal manufacturer.

K. Laminating Adhesive: Adhesive recommended by metal fabricator that will fully bond metal to metal, will prevent telegraphing and oil-canning, and is compatible with substrate and noncombustible after curing.

L. Isolation Coating: Manufacturer's standard [**alkali-resistant coating**][**bituminous paint**][**epoxy coating**].

2.5 PAINTS AND COATINGS

A. Etching Cleaner for Galvanized Metal: Product formulated to remove grease and oil residue from metal surfaces and provide a clean, lightly etched surface to promote adhesion of coatings.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible

with paints specified to be used over it.

C. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

D. Shop Primers: Comply with [**Section 099113 "Exterior Painting."**][**Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

E. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

F. Epoxy Zinc-Rich Primer: Compatible with topcoat.

G. Shop Primer for Galvanized Steel: [**Cementitious galvanized metal primer**][**Vinyl wash primer**][**Water-based galvanized metal primer**].

H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a **1/2-inch- (12-mm-)** wide hem on the concealed side, or ease edges to a radius of approximately **1/32 inch (1 mm)** and support with concealed stiffeners.

D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.

1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

E. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.

F. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.

G. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

1. Use welding and brazing procedures that will blend with and not cause discoloration of metal

being joined.

2.7 BEAM WRAPS

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

1. [**Hi-Tech Metals, Inc**]
2. [**Industrial Louvers Inc.**]
3. [**Metal Sales & Service, Inc.**]
4. [**MM Systems Corporation**]
5. [**SAF (Southern Aluminum Finishing Company, Inc.)**]
6. [**Southwest Metalsmiths, Inc.**]

B. Form beam wraps from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Steel Sheet: [**0.060 inch (1.52 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

C. Fabricate with calk stop angle to retain backer rod and sealant.

2.8 CLOSURES AND TRIM

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

1. [**Fry Reglet Corporation**]
2. [**Pittcon Industries**]

B. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction[**with weathertight joints at exterior installations**].

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance**

organic coating][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**][**Thickness required to comply with performance requirements**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view and not exposed to weather.

C. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.

D. Drill and tap holes needed for securing closures and trim to other surfaces.

E. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.

F. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

2.9 DECORATIVE-METAL-CLAD DOORS AND FRAMES

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

1. [**Dawson Metal Co., Inc**]
2. [**InKan Limited**]
3. [**Krieger Specialty Products Company**]

B. Laminate metal sheets, of type and thickness indicated below, to faces of [**hollow-metal doors and frames**][**and**][**elevator entrances**] where indicated. Use adhesive that will fully bond metal to metal and that will prevent telegraphing and oil-canning.

1. Bronze Sheet: [**0.040 inch (1.02 mm)**].

   a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish, lacquered**].

2. Brass Sheet: [**0.040 inch (1.02 mm)**].

   a. Finish: [**Buffed**][**Hand-rubbed**] finish lacquered.

3. Stainless Steel Sheet: [**0.038 inch (0.95 mm)**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

4. Titanium Sheet: [0.025 inch (0.64 mm)].

    a. Finish: [**Dull**][**Bright**] matte.

2.10 ESCALATOR ENCLOSURES

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

1. [**Hi-Tech Metals, Inc**]
2. [**Metal Sales & Service, Inc.**]
3. [**Southwest Metalsmiths, Inc.**]

B. Form escalator enclosures from metal of type and thickness indicated below. Coordinate size of enclosures, location of cutouts, and method of attachment to adjoining construction.

1. Stainless Steel Sheet: [0.062 inch (1.59 mm)][**Thickness required to comply with performance requirements**].

    a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2. Bronze Sheet: [0.081 inch (2.05 mm)][**Thickness required to comply with performance requirements**].

    a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish**].

2.11 FILLER PANELS

A. Form filler panels for closing ends of partition systems and for other applications indicated. Form from two sheets of metal of type and thickness indicated below, separated by channels formed from the same material, producing a panel of same thickness as [**partitions**][**mullions**] unless otherwise indicated. Incorporate reveals, trim, and concealed anchorages for attaching to adjacent surfaces.

1. Galvanized-Steel Sheet: [0.064 inch (1.63 mm)].

    a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

2. Steel Sheet: [0.060 inch (1.52 mm)].

    a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

3. Filler panels may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

B. Fill interior of panel with sound-deadening insulation permanently attached to inside panel faces.

C. Adhesively attach gaskets to filler panel edges where they abut mullions or glazing. Use 1-inch- (25-mm-) square material, unless otherwise indicated, set approximately 1/4 inch (6 mm) into channeled edge of filler panel.

D. Attach gaskets to all edges of panels that abut adjacent surfaces to form a continuous seal. Use compressible gaskets or mastic sealing tape, applied to center of panel edges to be concealed from view, unless otherwise indicated.

E. Do not mechanically fasten filler panels to mullions.

2.12 LIGHTING COVES

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

1. [**Fry Reglet Corporation**]
2. [**Gordon Inc.**]
3. [**Hi-Tech Metals, Inc**]
4. [**MM Systems Corporation**]
5. [**Pittcon Industries**]

B. Form lighting coves from metal of type and thickness indicated below. Coordinate size of coves, location of cutouts for electrical wiring, and method of attachment to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Fabricate light coves with [**hairline butt joints**][**tapered edges for taping and spackling**].
5. Provide [**mitered corners, factory welded with backplates**][**factory endcaps**].
6. Lighting coves may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

2.13 METAL BASE

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

1. [**Fry Reglet Corporation**]
2. [**Pittcon Industries**]

B. Form metal base from metal of type and thickness indicated below:

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

    a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**].

    a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2.14 MULLION CLADDING

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

1. [**Hi-Tech Metals, Inc**]
2. [**Metal Sales & Service, Inc.**]
3. [**Southwest Metalsmiths, Inc.**]

B. Form mullion cladding from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

    a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

    a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**].

    a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

2.15 PIPE SYSTEM COVERS

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

1. [**ARSCO Metals LLC**]
2. [**JG Innovations, Inc.**]

B. Form pipe system covers from metal of type and thickness indicated below. Coordinate size of covers, location of cutouts for piping, and method of attachment to adjoining construction.

1. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

    a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance**

organic coating][**Powder coat**].

2. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

2.16 POCKETS FOR WINDOW TREATMENT

A. Form pockets from metal of type and thickness indicated below, with end closures. Coordinate dimensions and attachment methods with window treatment equipment, window frames, ceiling suspension system, and other related construction to produce a coordinated, closely fitting assembly.

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Steel Sheet: [**0.048 inch (1.21 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Powder coat**].

4. Pockets for window treatment may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

B. Reinforce pockets for attaching window treatment equipment and hardware, or increase metal thickness.

C. Divide continuous pockets with built-in partitions located to separate adjoining drapery and blind units, to coincide with window mullions, and to receive filler panels at ends of partitions.

2.17 WINDOW STOOLS

A. Form window stools from metal of type and thickness indicated below, with end closures:

1. Aluminum Sheet: [**0.063 inch (1.60 mm)**].

   a. Finish: [**Baked enamel or powder coat**][**Siliconized polyester**][**High-performance organic coating**][**Mill**][**Clear anodic**][**Color anodic**].

2. Galvanized-Steel Sheet: [**0.052 inch (1.32 mm)**].

   a. Finish: [**Factory primed**][**Baked enamel**][**Siliconized polyester**][**High-performance organic coating**][**Powder coat**].

3. Stainless Steel Sheet: [**0.050 inch (1.27 mm)**][**1.3 mm**].

   a. Finish: [**No. 2B**][**No. 4**][**No. 6**][**No. 7**][**No. 8**].

4. Bronze Sheet: [**0.051 inch (1.29 mm)**].

   a. Finish: [**Buffed finish, lacquered**][**Hand-rubbed finish, lacquered**][**Statuary conversion coating over satin finish**].

B. Weld seams at end closures.

C. Braze seams at end closures.

D. Apply sound-deadening [**insulation**][**mastic**] to underside of window stools.

2.18 GENERAL FINISH REQUIREMENTS

A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

D. Finish [**items indicated on Drawings**] after assembly.

E. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.19 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

B. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

1. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**].
2. [**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

D. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Superior-Performing Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.20 GALVANIZED-STEEL SHEET FINISHES

A. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

B. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

D. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of **1 mil (0.025 mm)** for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

F. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

G. Siliconized-Polyester Coating: Immediately after cleaning and pretreating, apply manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

H. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

I. Superior-Performing Organic Finish: [**Two**][**Three**][**Four**]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.21 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating.

C. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

D. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils (0.05 mm)**.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

E. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than **1.5 mils (0.04 mm)**. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.22 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

D. Directional Satin Finish: No. 4.

E. Dull Satin Finish: No. 6.

F. Satin, Reflective, Directional Polish: No. 7.

G. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.

H. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.23 COPPER-ALLOY FINISHES

A. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

B. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

C. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

D. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

E. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)[**with color matching Architect's sample**].

F. Statuary Conversion Coating over Satin Finish, Lacquered: M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air dried, as specified below)[**with color matching Architect's sample**]:

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil (0.025 mm)**.

2.24 TITANIUM FINISHES

A. General: Fabricate items from finished titanium sheet, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective

covering.

B. Dull Matte Finish: Pickled and annealed.

C. Bright Matte Finish: Vacuum annealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.

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

3.2 INSTALLATION

A. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.

E. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.

F. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

G. Install decorative-formed-metal-clad doors and frames to comply with requirements specified in Section 081113 "Hollow Metal Doors and Frames."

3.3 ADJUSTING AND CLEANING

A. Unless otherwise indicated, clean metals by washing thoroughly with water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**][**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."**]

D. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 05 75 00 00

Task	Specification	Specification Description
05 75 00 00	05 70 00 00	Decorative Metal

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Task	Specification	Specification Description
06 05 23 00	06 10 00 00	Rough Carpentry
06 05 23 00	06 13 00 00	Heavy Timber Construction
06 05 73 13	01 22 00 00	No Specification Required
06 05 73 33	06 10 00 00	Rough Carpentry
06 05 73 33	06 13 00 00	Heavy Timber Construction

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SECTION 06 10 00 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood products.
2. Wood-preservative-treated lumber.
3. Fire-retardant-treated lumber.
4. Dimension lumber framing.
5. Miscellaneous lumber.
6. Plywood backing panels.
7. Metal framing anchors.

B. Related Requirements:

1. Section 061533 "Wood Patio Decking" for elevated decks, including support framing.
2. Section 061600 "Sheathing" for sheathing, subflooring, and underlayment.
3. Section 061753 "Shop-Fabricated Wood Trusses" for wood trusses made from dimension lumber.
4. Section 064013 "Exterior Architectural Woodwork" for exterior wood stairs and railings.
5. Section 064023 "Interior Architectural Woodwork" for interior wood stairs and railings.
6. Section 313116 "Termite Control" for site application of borate treatment to wood framing.

1.2 DEFINITIONS

A. Boards or Strips: Lumber of less than **2 inches nominal (38 mm actual)** size in least dimension.

B. Dimension Lumber: Lumber of **2 inches nominal (38 mm actual)** size or greater but less than **5 inches nominal (114 mm actual)** size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

D. SBX: An inorganic boron used to prevent termites and fungal decay.

E. Lumber grading agencies, and abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Chain-of-Custody Qualification Data: For manufacturer and vendor.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.5 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. For exposed lumber indicated to receive a stained or natural finish, [**mark grade stamp on end or back of each piece**][**or**][**omit grade stamp and provide certificates of grade compliance issued by grading agency**] .
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:

1. Boards: [**15**][**19**] percent.
2. Dimension Lumber: [**15 percent**][**19 percent**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**][**19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**] unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Wood-Preservative-Treated Lumber by Pressure Process: AWPA U1, use categories as follows:

1. UC1, Interior/Dry: Interior construction continuously protected from weather or other sources of moisture. Include [**all rough carpentry.**][**the following items:**]

   a. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
   b. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   c. Wood floor plates that are installed over concrete slabs-on-grade.
   d. Wood furniture.
   e. Wood millwork.

2. UC2, Interior/Damp: Interior construction protected from weather, but may be subject to sources of moisture. Include [**all rough carpentry.**][**the following items:**]

   a. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
   b. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   c. Wood floor plates that are installed over concrete slabs-on-grade.
   d. Wood millwork.
   e. Wood flooring.

3. UC3A, Above Ground, Protected (Commodity Specification A): Coated wood products in exterior construction not in contact with ground but exposed to all weather cycles including intermittent wetting. Include [**all rough carpentry.**][**the following items:**]

   a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
   c. Wood siding and trim.

4. UC3A, Above Ground, Protected (All Other Commodity Specifications): Wood products in exterior

construction not in contact with ground, exposed to all weather cycles but either coated and installed in a manner that prevents prolonged wetting, or fully protected from liquid water by building design and construction. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
c. Wood floor plates that are installed over concrete slabs-on-grade.
d. Wood siding and trim.
e. Wood sheathing.

5. UC3B, Above Ground, Exposed (Commodity Specification A): Uncoated wood products in exterior construction not in contact with ground, exposed to all weather cycles including intermittent wetting, but with sufficient air circulation for wood to dry. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
c. Wood decking, railings, and joists and beams for decks that are not critical to the performance and safety of the entire system/construction and that are in locations easily accessible for maintenance, repair, or replacement.

6. UC3B, Above Ground, Exposed (All Other Commodity Specifications): Uncoated wood products in exterior construction not in contact with ground, exposed to all weather cycles including prolonged wetting. Include [**all rough carpentry.**][**the following items:**]

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
b. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.

7. UC4A, Ground Contact, General Use (Commodity Specification A): Non-critical wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, and wood products not in contact with ground but with ground contact-type hazards or that are critical or hard to replace. Include [**all rough carpentry.**][**the following items:**]

a. Wood framing members that are less than **6 inches (152 mm)** above the ground.
b. Joists and beams when they are difficult to maintain, repair, or replace and are critical to the performance and safety of the entire system/construction.

8. UC4A, Ground Contact, General Use (All Other Commodity Specifications): Non-critical wood products in contact with ground and exposed to all weather cycles, normal exposure conditions. Include [**all rough carpentry.**][**the following items:**]

a. Wood fence, deck, and guardrail posts.
b. Wood utility poles.

9. UC4B, Ground Contact, Heavy Duty (Commodity Specification A): Critical or difficult-to-replace wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, high decay potential, and saltwater splash. Include [**all rough carpentry.**][**the following items:**]

a. Wood foundations.

10. UC4C, Ground Contact, Extreme Duty (Commodity Specification A): Critical structural wood products in contact with ground and exposed to all weather cycles including continuous or prolonged wetting, severe environments, and extreme decay potential. Include [**all rough carpentry.**][**the following items:**]

    a. Wood foundation piling.

11. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. [**Do not use inorganic boron (SBX) for sill plates.**]
12. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
13. After treatment, redry [**boards**][**dimension lumber**] to 19 percent maximum moisture content.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**] .

D. Application: Treat [**all rough carpentry unless otherwise indicated.**][**items indicated on Drawings, and the following:**]

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, [**furring,**][**stripping,**] and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than **18 inches (460 mm)** above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 ft. (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Treatment is not to promote corrosion of metal fasteners.
2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when

tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber is to be tested in accordance with ASTM D5664 and design value adjustment factors are to be calculated in accordance with ASTM D6841. [**For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.**]

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. [**Kiln-dry plywood after treatment to maximum moisture content of 15 percent.**]

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency and other information required by authorities having jurisdiction.

1. For exposed lumber indicated to receive a stained or natural finish, [**mark end or back of each piece**][**or**][**omit marking and provide certificates of treatment compliance issued by testing agency**] .

E. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat [**all rough carpentry unless otherwise indicated.**][**items indicated on Drawings, and the following:**]

1. Framing for raised platforms.
2. Framing for stages.
3. Concealed blocking.
4. Framing for non-load-bearing partitions.
5. Framing for non-load-bearing exterior walls.
6. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
7. Plywood backing panels.

2.4 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions by Grade:

1. Grade: [**Construction or No. 2**][**Construction, Stud, or No. 3**][**Standard, Stud, or No. 3**] .
2. Application: [**All interior partitions**][**Interior partitions not indicated as load bearing**] .
3. Species:

a. Hem-fir (north); NLGA.
b. Southern pine or mixed southern pine; SPIB.
c. Spruce-pine-fir; NLGA.
d. Hem-fir; WCLIB, or WWPA.
e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
f. Northern species; NLGA.
g. Eastern softwoods; NeLMA.
h. Western woods; WCLIB or WWPA.

B. Load-Bearing Partitions by Grade:

1. Grade: [**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] .

2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .
3. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Southern pine or mixed southern pine; SPIB.
    e. Spruce-pine-fir; NLGA.
    f. Douglas fir-south; WWPA.
    g. Hem-fir; WCLIB or WWPA.
    h. Douglas fir-larch (north); NLGA.
    i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

C. Machine Stress-Rated (MSR) Lumber Partitions:

1. Grade: Any species of MSR dimension lumber with a grade of not less than [**2400f-2.0E**][**2100f-1.8E**][**1650f-1.5E**].
2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .

D. Load-Bearing Partitions by Performance:

1. Performance Requirement: Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.
2. Application: [**Exterior walls**][**and**][**interior load-bearing partitions**] .

E. Ceiling Joists:

1. Grade: [**Construction or No. 2**][**Construction, Stud, or No. 3**][**Standard, Stud, or No. 3**] .
2. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Douglas fir-larch (north); NLGA.
    e. Southern pine or mixed southern pine; SPIB.
    f. Spruce-pine-fir; NLGA.
    g. Hem-fir; WCLIB or WWPA.
    h. Douglas fir-south; WWPA.
    i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
    j. Northern species; NLGA.
    k. Eastern softwoods; NeLMA.
    l. Western woods; WCLIB or WWPA.

F. Joists, Rafters, and Other Framing by Grade:

1. Grade: [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] .
2. Species:

    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Southern pine or mixed southern pine; SPIB.

e. Spruce-pine-fir; NLGA.
f. Douglas fir-south; WWPA.
g. Hem-fir; WCLIB or WWPA.
h. Douglas fir-larch (north); NLGA.
i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

G. Joists, Rafters, and Other Framing by Performance:

1. Performance Requirement: Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.

H. Exposed Framing: Hand-select material [**indicated to receive a stained or natural finish**] for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.

1. Species and Grade:

a. As indicated above for load-bearing construction of same type.
b. Hem-fir (north); [**Select Structural**][**No. 1**] grade; NLGA.
c. Southern pine; [**Select Structural**][**No. 1**][**No. 2**] grade; SPIB.
d. Douglas fir-larch; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.
e. Mixed southern pine; [**Select Structural**][**No. 1**][**No. 2**] grade; SPIB.
f. Spruce-pine-fir; [**Select Structural**][**No. 1**] grade; NLGA.
g. Douglas fir-south; [**Select Structural**][**No. 1**] grade; WWPA.
h. Hem-fir; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.
i. Douglas fir-larch (north); [**Select Structural**][**No. 1**] grade; NLGA.
j. Spruce-pine-fir (south); [**Select Structural**][**No. 1**] grade; NeLMA, WCLIB, or WWPA.
k. Eastern hemlock-balsam fir or eastern hemlock-tamarack; [**Select Structural**][**No. 1**] grade; NeLMA.
l. Beech-birch-hickory; [**Select Structural**][**No. 1**] grade; NeLMA.
m. Northern red oak; [**Select Structural**][**No. 1**] grade; NeLMA.
n. Redwood; [**Clear Heart Structural**][**Clear Structural**][**Select Structural**][**No. 1**] grade; RIS.
o. Mixed oak; [**Select Structural**][**No. 1**] grade; NeLMA.
p. Mixed maple; [**Select Structural**][**No. 1**] grade; NeLMA.
q. Western cedars; [**Select Structural**][**No. 1**] grade; WCLIB or WWPA.

2.5 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.
7. Utility shelving.

B. Dimension Lumber Items:

1. Grade: [**Construction or No. 2**][**Standard, Stud, or No. 3**] .
2. Species: [**Any species.**][**Any of the following species:**][**The following species:**]

a. Hem-fir (north); NLGA.
b. Mixed southern pine or southern pine; SPIB.
c. Spruce-pine-fir; NLGA.
d. Hem-fir; WCLIB or WWPA.
e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
f. Western woods; WCLIB or WWPA.
g. Northern species; NLGA.
h. Eastern softwoods; NeLMA.

C. Utility Shelving:

1. Lumber Moisture Content: [**15**][**19**] percent maximum.
2. Species and Grade:

a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; [**Premium or No. 2 Common (Sterling)**][**Standard or No. 3 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.
b. Mixed southern pine or southern pine; No. [**1**][**2**] grade; SPIB.
c. Hem-fir or hem-fir (north); [**Select Merchantable or No. 1 Common**][**Construction or No. 2 Common**] grade; NLGA, WCLIB, or WWPA.
d. Spruce-pine-fir (south) or spruce-pine-fir; [**Select Merchantable or No. 1 Common**][**Construction or No. 2 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.

D. Concealed Boards:

1. Lumber Moisture Content: [**15**][**19**] percent maximum.
2. Species and Grade: [**Any of the following:**][**The following:**]

a. Mixed southern pine or southern pine; No. [**2**][**3**] grade; SPIB.
b. Hem-fir or hem-fir (north); [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; NLGA, WCLIB, or WWPA.
c. Spruce-pine-fir (south) or spruce-pine-fir; [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; NeLMA, NLGA, WCLIB, or WWPA.
d. Eastern softwoods; No. [**2**][**3**] Common grade; NeLMA.
e. Northern species; No. [**2**][**3**] Common grade; NLGA.
f. Western woods; [**Construction or No. 2 Common**][**Standard or No. 3 Common**] grade; WCLIB or WWPA.

E. Roofing Nailers: Structural- or No. 2-grade lumber or better; kiln-dried Douglas fir, southern pine, or wood having similar decay-resistant properties.

F. Wood Blocking: For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

G. Wood Furring: For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.6 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1.

1. Grade: [**Exterior, A-C**][**Exterior, C-C Plugged**][**Exposure 1, C-D Plugged**][**, fire-retardant treated**] .
2. Thickness: As indicated on the drawings or, if not indicated, not less than [**1/2-inch (13-mm)**][**3/4-inch (19-mm)**] nominal thickness.

2.7 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329**][**of Type 304 stainless steel**] .
2. For redwood, use [**brass/bronze**][**stainless steel**][**hot-dip galvanized-steel**] fasteners.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on [**ICC-ES AC01**][**ICC-ES AC58**][**ICC-ES AC193**][**or**][**ICC-ES AC308**] as appropriate for the substrate.

2.8 ACCESSORIES

A. Metal Framing Anchors:

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

    a. [**MiTek Industries, Inc.**]
    b. [**Simpson Strong-Tie Co., Inc.**]
    c. [**Tamlyn**]

2. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post **1 inch (25 mm)** above base and with **2-inch- (50-mm-)** minimum side cover, socket **0.062 inch (1.6 mm)** thick, and standoff and adjustment plates **0.108 inch (2.8 mm)** thick.
3. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

    a. Width: [**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**] .
    b. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**] .
    c. Length: [**16 inches (400 mm)**][**24 inches (600 mm)**][**As indicated**] .

4. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, **1-1/2 inches (38 mm)** wide by **0.050 inch (1.3 mm)** thick. [**Tie fastens to side of rafter or truss, face of top plates, and side of stud below.**]
5. Rafter Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, **2-1/4 inches (57 mm)** wide by **0.062 inch (1.6 mm)** thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.
6. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, **1-1/4 inches (32 mm)** wide by **0.050 inch (1.3 mm)** thick by **36 inches (914 mm)** long.
7. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.

    a. Bolt Diameter: [**5/8 inch (15.8 mm)**][**3/4 inch (19 mm)**] .
    b. Width: [**2-1/2 inches (64 mm)**][**3-3/16 inches (81 mm)**] .
    c. Body Thickness: [**0.108 inch (2.8 mm)**][**0.138 inch (3.5 mm)**] .
    d. Base Reinforcement Thickness: [**0.108 inch (2.8 mm)**][**0.239 inch (6.1 mm)**] .

8. Wall Bracing:

    a. T-shaped bracing made for letting into studs in saw kerf, **1-1/8 inches (29 mm)** wide by **9/16 inch (14 mm)** deep by **0.034 inch (0.85 mm)** thick with hemmed edges.
    b. Angle bracing made for letting into studs in saw kerf, **15/16 by 15/16 by 0.040 inch (24 by 24 by 1 mm)** thick with hemmed edges.

9. Materials: Unless otherwise indicated, fabricate from the following materials:

    a. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, **G60 (Z180)** coating designation.

        1) Use for interior locations unless otherwise indicated.

    b. Heavy-Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); **G185 (Z550)** coating designation; and not less than **0.036 inch (0.9 mm)** thick.

        1) Use for wood-preservative-treated lumber and where indicated.

    c. Stainless steel bars and shapes complying with ASTM A276/A276M.

        1) Stainless Steel: Type [**304**][**316**] .
        2) Use for exterior locations and where indicated.

B. Sill-Sealer Gasket:

1. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; **1-inch (25-mm)** nominal thickness, compressible to **1/32 inch (0.8 mm)**; selected from manufacturer's standard widths to suit width of sill members indicated.
2. Closed-cell neoprene foam, **1/4 inch (6.4 mm)** thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Sill-Sealer Gasket and Termite Barrier: Self-adhering sheet consisting of **64 mils (1.6 mm)** of rubberized asphalt laminated on one side to a **4-mil- (0.10-mm-)** thick, polyethylene-film reinforcement, and with release liner on adhesive side [**; formulated for application with primer or surface**

conditioner that complies with VOC limits of authorities having jurisdiction] .

D. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than **0.025 inch (0.6 mm)**.

1. Compound Material: [**Butyl rubber**][**or**][**rubberized asphalt**] .

E. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

1. Verify adhesives have a VOC content of [**70**] g/L or less.
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

F. Water-Repellent Preservative: Formulation containing 3-iodo-2-propynyl butylcarbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION OF ROUGH CARPENTRY, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate [**furring,**] nailers, blocking, [**grounds,**] and similar supports to comply with requirements for attaching other construction.

C. Plywood Backing Panels: Install backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. [**Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.**]

D. Metal Framing Anchors: Install anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Sill-Sealer Gasket: Install gasket to form continuous seal between sill plates and foundation walls.

F. Sill-Sealer Gasket and Termite Barrier: Install gasket and termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

G. Do not splice structural members between supports unless otherwise indicated.

H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than **16 inches (406 mm)** o.c.

I. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than **96 inches (2438 mm)** o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than **96 inches (2438 mm)** o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and **2-inch nominal (38-mm actual)** thickness.
3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than **100 sq. ft. (9.3 sq. m)** and to solidly fill space below partitions.
4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than **20 ft. (6 m)** o.c.

J. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

K. Field Application of Preservative Treatment: Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron (SBX) for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

L. Flexible Flashing: Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

M. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in ICC's "International Building Code" (IBC).
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
3. ICC-ES evaluation report for fastener.

N. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF ROOFING NAILERS

A. Install roofing nailers where indicated on Drawings and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with

other work involved.

B. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.

C. Securely attach roofing nailers to substrate to resist the designed outward and upward wind loads indicated on Drawings and in accordance with SPRI ED-1, Tables A6 and A7.

3.3 INSTALLATION OF WOOD BLOCKING

A. Install wood blocking where indicated on Drawings and where required for [**screeding or**] attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than **1-1/2 inches (38 mm)** wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.4 INSTALLATION OF WOOD FURRING

A. Install wood furring level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install **1-by-3-inch nominal- (19-by-63-mm actual-)** size furring [**horizontally**][**and**][**vertically**] at [**24 inches (610 mm)**][**600 mm**] o.c.

C. Furring to Receive Gypsum Board or Plaster Lath: Install **1-by-2-inch nominal- (19-by-38-mm actual-)** size furring vertically at [**16 inches (406 mm)**][**400 mm**] o.c.

3.5 INSTALLATION OF WALL AND PARTITION FRAMING

A. General: Provide single bottom plate and double top plates using members of **2-inch nominal (38-mm actual)** thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions [**and for load-bearing partitions where framing members bearing on partition are located directly over studs**] . Fasten plates to supporting construction unless otherwise indicated.

1. For exterior walls, provide [**2-by-6-inch nominal- (38-by-140-mm actual-)**][**2-by-4-inch nominal- (38-by-89-mm actual-)**] size wood studs spaced [**24 inches (610 mm)**][**16 inches (406 mm)**][**600 mm**][**400 mm**] o.c. unless otherwise indicated.
2. For interior partitions and walls, provide [**2-by-6-inch nominal- (38-by-140-mm actual-)**][**2-by-4-inch nominal- (38-by-89-mm actual-)**][**2-by-3-inch nominal- (38-by-64-mm actual-)**] size wood studs spaced [**24 inches (610 mm)**][**16 inches (406 mm)**][**600 mm**][**400 mm**] o.c. unless otherwise indicated.
3. Provide continuous horizontal blocking at midheight of partitions more than **96 inches (2438 mm)** high, using members of **2-inch nominal (38-mm actual)** thickness and of same width as wall or partitions.

B. Construct corners and intersections with three or more studs [**, except that two studs may be used for interior non-load-bearing partitions**] .

C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.

1. For non-load-bearing partitions, provide double-jamb studs and headers not less than **4-inch nominal (89-mm actual)** depth for openings **48 inches (1200 mm)** and less in width, **6-inch nominal (140-mm actual)** depth for openings **48 to 72 inches (1200 to 1800 mm)** in width, **8-inch nominal (184-mm actual)** depth for openings **72 to 120 inches (1800 to 3000 mm)** in width, and not less than **10-inch nominal (235-mm actual)** depth for openings **10 to 12 ft. (3 to 3.6 m)** in width.
2. For load-bearing walls, provide double-jamb studs for openings **60 inches (1500 mm)** and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated [**or, if not indicated, in accordance with Table R602.7(1) or Table R602.7(2), as applicable, in ICC's "International Residential Code for One- and Two-Family Dwellings"**] .

D. Provide diagonal bracing in [**exterior walls, at both walls of each external corner**][**walls, at locations indicated on Drawings**] , at 45-degree angle, full-story height unless otherwise indicated. Use [**1-by-4-inch nominal- (19-by-89-mm actual-) size boards, let-in flush with faces of studs**][**metal wall bracing, let into studs in saw kerf**] .

3.6 INSTALLATION OF FLOOR JOIST FRAMING

A. General: Install floor joists with crown edge up and support ends of each member with not less than **1-1/2 inches (38 mm)** of bearing on wood or metal, or **3 inches (76 mm)** on masonry. Attach floor joists as follows:

1. Where supported on wood members, by [**toe nailing or by**] using metal framing anchors.
2. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.

B. Fire Cuts: At joists built into masonry, bevel cut ends **3 inches (76 mm)** and do not embed more than **4 inches (102 mm)**.

C. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds **48 inches (1200 mm)**.

D. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than one-third depth of joist; do not locate closer than **2 inches (50 mm)** from top or bottom.

E. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist at ends of joists unless nailed to header or band.

F. Lap members framing from opposite sides of beams, girders, or partitions not less than **4 inches (102 mm)** or securely tie opposing members together. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist over supports.

G. Anchor members paralleling masonry with **1/4-by-1-1/4-inch (6.4-by-32-mm)** metal strap anchors spaced not more than **96 inches (2438 mm)** o.c., extending over and fastening to three joists. Embed anchors at least **4 inches (102 mm)** into grouted masonry with ends bent at right angles and extending **4 inches (102 mm)** beyond bend.

H. Provide solid blocking between joists under jamb studs for openings.

I. Under non-load-bearing partitions, provide double joists separated by solid blocking equal to depth of studs above.

1. Provide triple joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures.

J. Provide bridging of type indicated below, at intervals of **96 inches (2438 mm)** o.c., between joists.

1. Diagonal wood bridging formed from bevel-cut, **1-by-3-inch nominal- (19-by-64-mm actual-)** size lumber, double-crossed and nailed at both ends to joists.
2. Steel bridging installed to comply with bridging manufacturer's written instructions.

3.7 INSTALLATION OF CEILING JOIST AND RAFTER FRAMING

A. Ceiling Joists: Install with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.

1. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate, and nail to first joist or anchor with framing anchors or metal straps. Provide **1-by-8-inch nominal- (19-by-184-mm actual-)** size or **2-by-4-inch nominal- (38-by-89-mm actual-)** size stringers spaced **48 inches (1200 mm)** o.c. crosswise over main ceiling joists.

B. Rafters: Notch to fit exterior wall plates and [**toe nail or**] use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.

1. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and **2 inches (50 mm)** deeper. Bevel ends of jack rafters for full bearing against valley rafters.
2. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and **2 inches (50 mm)** deeper. Bevel ends of jack rafters for full bearing against hip rafter.

C. Provide collar beams (ties) as indicated or, if not indicated, provide **1-by-6-inch nominal- (19-by-140-mm actual-)** size boards between every third pair of rafters, but not more than **48 inches (1219 mm)** o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.

D. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions if any.

3.8 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00 00

Task	Specification	Specification Description
06 11 13 00	06 10 00 00	Rough Carpentry
06 11 16 00	01 22 00 00	No Specification Required
06 11 16 00	06 10 00 00	Rough Carpentry

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SECTION 06 13 00 00 - HEAVY TIMBER CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Timber.
2. Round wood poles.
3. Preservative-treated wood material.
4. Timber connectors.
5. Miscellaneous materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with heavy timber framing.
2. Section 061516 "Wood Roof Decking."
3. Section 061800 "Glued-Laminated Construction."

1.2 DEFINITIONS

A. Timbers: Lumber of **5 inches nominal (114 mm actual)** or greater in least dimension.

B. Poles: Round wood members, called either "poles" or "posts" in the referenced standards.

C. Inspection agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NHLA: National Hardwood Lumber Association.
3. NLGA: National Lumber Grades Authority.
4. SPIB: Southern Pine Inspection Bureau (The).
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For [**preservative-treated wood products**][**and**][**timber connectors**].

1. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. For timber connectors. Include installation instructions.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.

3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Shop Drawings: For heavy timber framing. Show layout, dimensions of each member, and details of connections.

D. Samples: Not less than [**5 inches (127 mm)**][**7 inches (178 mm)**][**9 inches (229 mm)**] wide by **24 inches (600 mm)** long, showing the range of variation to be expected in appearance, including surface texture, of wood products.[**Apply a coat of penetrating sealer to Samples.**]

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For timbers specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.[**For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.**]

B. Certificates of Inspection: Issued by lumber-grading agency for exposed timber not marked with grade stamp.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of materials to avoid extended on-site storage and to avoid delaying the Work.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings.

PART 2 - PRODUCTS

2.1 WOOD MATERIALS, GENERAL

A. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

I. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

J. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 TIMBER

A. Comply with DOC PS 20 and with grading rules of lumber-grading agencies certified by ALSC's Board of Review as applicable.

1. Factory mark each item of timber with grade stamp of grading agency.
2. For exposed timber indicated to receive a stained or natural finish, apply grade stamps to surfaces that are not exposed to view, or omit grade stamps and provide certificates of grade compliance issued by grading agency.

B. Timber Species and Grade:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); [**Select Structural**][**No. 1**][**No. 2**], NeLMA, NLGA, SPIB, WCLIB, or WWPA.
2. Alaska cedar; [**Select Structural**][**No. 1**][**No. 2**], WCLIB.
3. Douglas fir-larch or Douglas fir-larch (North); [**Dense Select Structural**][**Select Structural**][**No. 1 Dense**][**No. 1**][**No. 2**], NLGA, WCLIB, or WWPA.
4. Hem-fir or hem-fir (North); [**Select Structural**][**No. 1**][**No. 2**], NLGA, WCLIB, or WWPA.
5. Southern pine; [**Dense Select Structural**][**Select Structural**][**No. 1 Dense**][**No. 1**][**No. 2 Dense**][**No. 2**], SPIB.
6. [**Beech-birch-hickory**][**Mixed maple**][**Mixed oak**][**Northern red oak**][**Red maple**][**Red oak**][**White oak**]; [**Select Structural**][**No. 1**][**No. 2**], NeLMA.
7. [**Mixed hardwoods**][**Mixed oak**][**Red oak**][**White oak**]; [**Select Dimension**][**Common Dimension**][**Sound Square Edge**], NHLA.

C. Structural Properties: Provide any species and grade that, for moisture content provided, complies with required structural properties.

1. Allowable Stress Ratings for 12-Inch Nominal (286-mm Actual) Depth: [**Fb 1500 psi (10.3 MPa) and E 1,500,000 psi (10 340 MPa)**][**Fb 1300 psi (9.0 MPa) and E 1,300,000 psi (8 960 MPa)**][**As indicated on Drawings**].

D. Moisture Content: Provide timber with 19 percent maximum moisture content at time of dressing[**or provide timber that is unseasoned at time of dressing but with 19 percent maximum moisture content at time of installation**].

E. Dressing: Provide [**dressed timber (S4S)**][**timber that is rough sawn (Rgh)**] unless otherwise indicated.

2.3 ROUND WOOD POLES

A. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

2.4 PRESERVATIVE-TREATED WOOD MATERIAL

A. Pressure-treat materials with waterborne preservative according to AWPA U1; Use Category UC2[**for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground**].

B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or

chromium.

1. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants, bleed through, or otherwise adversely affect finishes.

C. Use process that includes water-repellent treatment.

D. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.

E. After treatment, redry materials to 19 percent maximum moisture content.

F. Mark treated materials with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For exposed items indicated to receive a stained or natural finish, [**mark each piece on surface that is not exposed**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

G. Application: [**Treat all heavy timber framing unless otherwise indicated.**][**Treat items indicated on Drawings and the following:**]

1. Sills and similar members in contact with masonry or concrete.
2. Timber framing members less than **18 inches (460 mm)** above grade.

2.5 TIMBER CONNECTORS

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

1. [**Halfen USA, Inc.**]
2. [**Simpson Strong-Tie Co., Inc.**]
3. [**USP Structural Connectors**]

B. Fabricate beam seats from [**steel**][**stainless steel**] with [**0.239-inch (6-mm)**][**3/16-inch (5-mm)**][**3/8-inch (9.5-mm)**] bearing plates, **3/4-inch- (19-mm-)** diameter-by-**12-inch- (300-mm-)** long deformed bar anchors, and **0.239-inch (6-mm)** side plates.

C. Fabricate beam hangers from [**steel**][**stainless steel**] with **0.179-inch (4.6-mm)** stirrups and **0.239-inch (6-mm)** top plates.

D. Fabricate strap ties from [**steel**][**stainless steel**], [**2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm)**][**3 inches (75 mm) wide by 0.239 inch (6 mm)**] thick.

E. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A668/A668M.

F. Provide bolts, **3/4 inch (19 mm)** unless otherwise indicated, complying with **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**; provide nuts complying with **ASTM A563 (ASTM A563M)**; and, where indicated, provide flat washers.

G. Provide stainless steel bolts, **3/4 inch (19 mm)** unless otherwise indicated, complying with **ASTM F593,**

Alloy Group 1 or 2 (ASTM F738M, Grade A1 or A4); provide nuts complying with ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or A4); and, where indicated, provide flat washers.

H. Provide shear plates, [2-5/8 inches (66.7 mm)][4 inches (102 mm)] in diameter, complying with ASTM D5933.

I. Materials: Unless otherwise indicated, fabricate from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A36/A36M.
2. Round steel bars complying with ASTM A575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A1011/A1011M, Structural Steel, Type SS, Grade 33.
4. Stainless steel plate, sheet, and strip complying with ASTM 240/A240M or ASTM A666, [**Type 304**][**Type 316**].
5. Stainless steel flat bars complying with ASTM A666, [**Type 304**][**Type 316**].
6. Stainless steel bars and shapes complying with ASTM A276, [**Type 304**][**Type 316**].

J. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.

K. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A123/A123M or ASTM A153/A153M.

2.6 MISCELLANEOUS MATERIALS

A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.7 FABRICATION

A. Camber: Fabricate horizontal members and inclined members with a slope of less than 1:1, with natural convex bow (crown) up, to provide camber.

B. Shop fabricate members by cutting and restoring exposed surfaces to match specified surfacing. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.

C. Predrill for fasteners and assembly of units.

D. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.

1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Coat crosscuts with end sealer.

F. Seal Coat: After fabricating and surfacing each unit, apply a saturation coat of penetrating sealer on surfaces of each unit except for treated wood where the treatment included a water repellent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Erect heavy timber framing true and plumb. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

1. Install horizontal and sloping members with crown edge up, and provide not less than **4 inches (102 mm)** of bearing on supports. Provide continuous members unless otherwise indicated; tie together over supports with metal strap ties if not continuous.
2. Handle and temporarily support heavy timber framing to prevent surface damage, compression, and other effects that might interfere with indicated finish.

B. Framing Built into Masonry: Provide **1/2-inch (13-mm)** clearance at tops, sides, and ends of members built into masonry, and bevel cut ends **3 inches (76 mm)**; do not embed more than **4 inches (102 mm)** unless otherwise indicated.

C. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.

D. Fitting: Fit members by cutting and restoring exposed surfaces to match specified surfacing.

1. Predrill for fasteners using timber connectors as templates.
2. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Coat crosscuts with end sealer.
4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

    a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
    b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Install timber connectors as indicated.

1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
2. Install bolts with orientation as indicated or, if not indicated, as directed by the Owner.

3.2 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber framing if repairs are not approved by Architect, as directed by the Owner.

END OF SECTION 06 13 00 00

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Task	Specification	Specification Description
06 13 23 00	06 13 00 00	Heavy Timber Construction

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SECTION 06 15 00 00 - WOOD ROOF DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-sawn wood roof decking.
2. Glued-laminated wood roof decking.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with wood roof decking.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For glued-laminated wood roof decking, include installation instructions and data on lumber, adhesives, and fabrication.
2. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Samples: **24 inches (600 mm)** long, showing the range of variation to be expected in appearance of wood roof decking.

1.3 INFORMATIONAL SUBMITTALS

A. Research/Evaluation Reports: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, from ICC-ES.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of wood roof decking to avoid extended on-site storage and to avoid delaying the Work.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood roof decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 WOOD ROOF DECKING, GENERAL

A. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

2.2 SOLID-SAWN WOOD ROOF DECKING

A. Standard for Solid-Sawn Wood Roof Decking: Comply with AITC 112.

B. Roof Decking Species:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), hem-fir, hem-fir (North), southern pine, spruce pine-fir (North), western hemlock, or western hemlock (North).
2. [**Alaska cedar**][**Balsam fir**][**Douglas fir-larch or Douglas fir-larch (North)**][**Eastern spruce**][**Hem-fir or hem-fir (North)**][**Southern pine**].

C. Roof Decking Nominal Size: [**2 by 6**][**2 by 8**][**3 by 6**][**4 by 6**].

D. Roof Decking Grade:

1. [**Select(ed)**][**Commercial**] Decking.
2. [**Dense Standard**][**Dense Select**][**Select**][**Dense Commercial**][**Commercial**] Decking.
3. [**Select(ed) Decking or Select Dex**][**Commercial Decking or Commercial Dex**].

E. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that are not exposed to view.

F. Moisture Content: Provide wood roof decking with [**15**][**19**] percent maximum moisture content at time of dressing.

G. Face Surface: [**Rough sanded or wire brushed**][**Saw textured**][**Smooth**].

H. Edge Pattern: [**Beaded edge**][**Bullnosed**][**Channel grooved**][**Vee grooved**].

2.3 GLUED-LAMINATED WOOD ROOF DECKING

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

1. [**Structural Wood Systems; A Division of Harrison Industries**]

B. Face Species: [**Alaska cedar**][**Douglas fir-larch or Douglas fir-larch (North)**][**Ponderosa pine**][**Southern pine**][**Western cedars or western cedars (North)**].

C. Roof Decking Nominal Size: [**2 by 6**][**2 by 8**][**3 by 6**][**3 by 8**][**4 by 6**][**4 by 8**][**5 by 6**][**5 by 8**].

D. Roof Decking Configuration: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, provide tongue-and-groove configuration that complies with research/evaluation report.

E. Face Grade:

1. Custom or Supreme: Clear face is required. Occasional pieces may contain a small knot or minor characteristic that does not detract from the overall appearance.
2. Decorative: Sound knots and natural characteristics are allowed, including chipped edge knots, short end splits, seasoning checks, and some pin holes. Face knot holes, stains, end slits, skips, roller splits, and planer burns are not allowed.
3. Service: Face knot holes, stains, end splits, skips, roller splits, planer burns, and other nonstrength-reducing characteristics are allowed. Strength-reducing characteristics are not allowed.

F. Moisture Content: Provide wood roof decking with 15 percent maximum moisture content at time of dressing.

G. Face Surface: [**Rough sanded or wire brushed**][**Saw textured**][**Smooth**].

H. Edge Pattern: [**Beaded edge**][**Bullnosed**][**Channel grooved**][**Vee grooved**].

I. Laminating Adhesive: Wet-use type complying with ASTM D2559.

2.4 PRESERVATIVE TREATMENT

A. Pressure treat wood roof decking in accordance with AWPA U1; Use Category UC2.

1. For laminated roof decking, treat lumber before gluing.

B. Preservative Chemicals: [**Inorganic boron (SBX)**][**Acceptable to authorities having jurisdiction and containing no arsenic or chromium**].

1. For exposed items indicated to receive a stained or natural finish, use products that do not contain colorants, bleed through, or otherwise adversely affect finishes.

C. Use process that includes water-repellent treatment.

D. Use process that does not include water repellents or other substances that might interfere with

application of indicated finishes.

E. After treatment, redry materials to [**15**][**19**] percent maximum moisture content.

F. After dressing and fabricating roof decking, apply [**inorganic boron**][**copper naphthenate**] in accordance with AWPA M4 to surfaces cut to a depth of more than **1/16 inch (1.5 mm)**.

2.5 ACCESSORY MATERIALS

A. Fasteners for Solid-Sawn Roof Decking: Provide fastener size and type complying with AITC 112 for thickness of deck used.

B. Fasteners for Glued-Laminated Roof Decking: Provide fastener size and type complying with requirements in "Installation" Article for installing laminated roof decking.

C. Nails: Common; complying with ASTM F1667, Type I, Style 10.

D. Spikes: Round; complying with ASTM F1667, Type III, Style 3.

E. Fastener Material: Hot-dip galvanized steel.

F. Bolts for Anchoring Roof Decking to Walls: Carbon steel; complying with **ASTM A307 (ASTM F568M)** with **ASTM A563 (ASTM A563M)** hex nuts and, where indicated, flat washers[**, all hot-dip zinc coated**].

G. Installation Adhesive: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.

H. Sealants: Latex, complying with applicable requirements in Section 079200 "Joint Sealants" and recommended by sealant manufacturer and manufacturer of substrates for intended application.

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

    a. [**Bostik; Arkema**]
    b. [**May National Associates, Inc.; a subsidiary of Sika Corporation**]
    c. [**Pecora Corporation**]
    d. [**Permathane; a Holcim brand**]
    e. [**Tremco Incorporated**]

I. Penetrating Sealer: Clear sanding sealer complying with Section 099300 "Staining and Transparent Finishing" and compatible with topcoats specified for use over it.

2.6 FABRICATION

A. Shop Fabrication: Where preservative-treated roof decking is indicated, complete cutting, trimming, surfacing, and sanding before treating.

B. Predrill roof decking for lateral spiking to adjacent units to comply with AITC 112.

C. Seal Coat: After fabricating and surfacing roof decking, apply a saturation coat of penetrating sealer[**in fabrication shop**].

D. Apply indicated finish materials to comply with Section 099300 "Staining and Transparent Finishing" in fabrication shop.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and support framing in areas to receive wood roof decking for compliance with installation tolerances and other conditions affecting performance of wood roof decking.

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

3.2 INSTALLATION

A. Install solid-sawn wood roof decking to comply with AITC 112.

1. Locate end joints for [**two-span continuous lay-up**][**combination simple and two-span continuous lay-up**][**controlled random lay-up**][**lay-up indicated**].

B. Install laminated wood roof decking to comply with manufacturer's written instructions.

1. Locate end joints for [**two-span continuous lay-up**][**combination simple and two-span continuous lay-up**][**controlled random lay-up**][**lay-up indicated**].
2. Nail each course of glued-laminated wood roof decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.

    a. Use 12d nails for 2-by-6 and 2-by-8 roof decking.
    b. Use 30d nails for 3-by-6 and 3-by-8 roof decking.
    c. Use 60d nails for 4-by-6 and 4-by-8 roof decking. Predrill roof decking to prevent splitting.
    d. Use 30d tongue nails in bottom tongue and **3/8-inch (10-mm)** face spikes for 5-by-6 and 5-by-8 roof decking. Predrill roof decking at spikes to prevent splitting.

3. Slant nail each course of glued-laminated wood roof decking to the tongue of the adjacent course at **30 inches (750 mm)** o.c. and within **12 inches (300 mm)** of the end of each unit. Stagger nailing **15 inches (380 mm)** in adjacent courses.

    a. Use 6d nails for 2-by-6 and 2-by-8 roof decking.
    b. Use 8d nails for 3-by-6 and 3-by-8 roof decking.
    c. Use 10d nails for 4-by-6 and 4-by-8 roof decking.
    d. Use 16d nails for 5-by-6 and 5-by-8 roof decking.

4. Glue adjoining roof decking courses together by applying a **3/8-inch (10-mm)** bead of adhesive to the top of tongues, according to research/evaluation report.

C. Anchor wood roof decking, where supported on walls, with bolts as indicated.

D. Where preservative-treated roof decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

1. For solid-sawn roof decking, use inorganic boron (SBX).
2. For laminated roof decking, use copper naphthenate.

E. Apply joint sealant to seal roof decking at exterior walls at the following locations:

1. Between roof decking and supports located at exterior walls.
2. Between roof decking and exterior walls that butt against underside of roof decking.
3. Between tongues and grooves of roof decking over exterior walls and supports at exterior walls.

3.3 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged roof decking if repairs are not approved by Architect, as directed by the Owner.

3.4 PROTECTION

A. Provide water-resistive barrier over roof decking as the Work progresses to protect roof decking until roofing is applied.

B. If, despite protection, [**inorganic boron (SBX)-treated**] roof decking becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 15 00 00

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SECTION 06 15 00 00A - WOOD PATIO DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood decking.
2. Wood stair treads.
3. Wood railings.
4. Wood benches.
5. Plastic decking.

B. Related Requirements:

1. Section 072500 "Weather Barriers" for flexible flashing used with patio decking.
2. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing used with patio decking.

1.2 DEFINITIONS

A. Boards: Lumber of less than **2 inches nominal (38 mm actual)** in thickness and **2 inches nominal (38 mm actual)** or greater in width.

B. Dimension Lumber: Lumber of **2 inches nominal (38 mm actual)** or greater but less than **5 inches nominal (114 mm actual)** in least dimension.

C. Timber: Lumber of **5 inches nominal (114 mm actual)** or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For [**preservative-treated wood products**][**plastic decking**][**and**][**metal framing anchors**].

1. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. For [**plastic decking**][**and**][**metal framing anchors**]. Include installation instructions.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point

of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.
10. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
11. Chain-of-Custody Qualification Data: For manufacturer and vendor.

C. Samples: For plastic decking, not less than **24 inches (600 mm)** long, showing the range of variation to be expected in appearance of decking, including surface texture.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.[**For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.**]

B. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

C. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood products.
2. Plastic decking.
3. Expansion anchors.
4. Metal framing anchors.
5. Decking fasteners.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

B. Handle and store plastic lumber to comply with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.

1. Factory mark each item with grade stamp of grading agency.
2. For items that are exposed to view in the completed Work, [**mark grade stamp on end or back of each piece**][**or**][**omit grade stamp and provide certificates of grade compliance issued by grading agency**].
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Provide dressed lumber, S4S, unless otherwise indicated.

B. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Wood products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Wood products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

H. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to

FSC STD-01-001 and FSC STD-40-004.

I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

J. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

L. Maximum Moisture Content:

1. Boards: [**15**][**19**] percent.
2. Dimension Lumber: [**15 percent**][**19 percent**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness**][**15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**][**19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness**].
3. Timber. [**19 percent**][**No limit**].

2.2 WOOD DECKING

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Dimension Lumber Decking:

1. [**No. 2**][**Construction or No. 2**] grade and[**any of**] the following species:

   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.

2. [**Deck Heart or Construction Heart**][**Deck Common or Construction Common**] redwood; RIS.

C. Radius-Edged Board Decking: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir-larch or Douglas fir-south, [**Patio 1**][**Patio 2**]; WWPA.
2. Douglas fir-larch, [**Select Dex**][**Commercial Dex**]; WCLIB.
3. Douglas fir-larch (North), [**Select Patio**][**Commercial Patio**]; NLGA.
4. Hem-fir, [**Patio 1**][**Patio 2**]; WWPA.
5. Hem-fir, [**Select Dex**][**Commercial Dex**]; WCLIB.
6. Hem-fir (North), [**Select Patio**][**Commercial Patio**]; NLGA.
7. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
8. Southern pine, [**Premium**][**Standard**]; SPIB.
9. Western red cedar, [**Patio 1**][**Patio 2**]; WWPA.

10. Western red cedar, [**Select Dex**][**Commercial Dex**]; WCLIB.
11. Western red cedar (North), [**Select Patio**][**Commercial Patio**]; NLGA.

D. S4S Board Decking: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness radius-edged, with one face free of planer skip, machine burn, and torn or chipped grain.

1. Species: [**Ipe**][**Teak**][**Cumaru**][**Garapa**][**Goncalo alves**].
2. Grade Characteristics:

a. Clear[**one face; small pin knots and worm holes allowed on back face**].
b. Sound; small pin knots, worm holes, and fixed knots allowed.
c. All heart[**one face**].
d. Straight grained and parallel cut.
e. Free of heart centers.
f. No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
g. No discoloration.

2.3 WOOD STAIR TREADS

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Radius-Edged Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir-larch or Douglas fir-south, [**Patio 1**][**Patio 2**]; WWPA.
2. Douglas fir-larch, [**Select Dex**][**Commercial Dex**]; WCLIB.
3. Douglas fir-larch (North), [**Select Patio**][**Commercial Patio**]; NLGA.
4. Hem-fir, [**Patio 1**][**Patio 2**]; WWPA.
5. Hem-fir, [**Select Dex**][**Commercial Dex**]; WCLIB.
6. Hem-fir (North), [**Select Patio**][**Commercial Patio**]; NLGA.
7. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
8. Southern pine, [**Premium**][**Standard**]; SPIB.
9. Western red cedar, [**Patio 1**][**Patio 2**]; WWPA.
10. Western red cedar, [**Select Dex**][**Commercial Dex**]; WCLIB.
11. Western red cedar (North), [**Select Patio**][**Commercial Patio**]; NLGA.

C. Half-Round or Rounded-Edged Nosing Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness of[**any of**] the following species and grades:

1. Douglas fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, [**Edge Grain B & B stepping**][**Near Rift B & B stepping**][**B & B stepping**]; SPIB.

D. S4S Board Stair Treads: [**1-1/4-inch (32-mm)**][**1-inch (25-mm)**][**3/4-inch (19-mm)**] actual thickness radius-edged, with one face free of planer skip, machine burn, and torn or chipped grain.

1. Species: [**Ipe**][**Teak**][**Cumaru**][**Garapa**][**Goncalo alves**].
2. Grade Characteristics:

a. Clear[**one face; small pin knots and worm holes allowed on back face**].
b. Sound; small pin knots, worm holes, and fixed knots allowed.
c. All heart[**one face**].
d. Straight grained and parallel cut.

e. Free of heart centers.
f. No decay, incipient decay, honeycomb, knot holes, shakes, splits, or wane.
g. No discoloration.

2.4 WOOD RAILINGS

A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Dimension Lumber Railing Members:

1. [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**] grade and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

2. [**Heart Clear**][**Heart B or Select Heart**] redwood; RIS.

C. Railing Boards:[**Any of the following species and grades:**]

1. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, B & B finish; SPIB.

D. Radius-Edged Railing Boards: [**Ipe**][**Teak**] S4S boards, [**same grade as decking**][**clear**][**clear all heart**][**, straight grained and parallel cut**].

2.5 WOOD BENCHES

A. Dimension Lumber for Benches:

1. [**Select Structural**][**No. 1**] grade and[**any of**] the following species:

a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Redwood; RIS.
e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

2. [**Heart Clear**][**Heart B or Select Heart**] redwood; RIS.

B. Boards for Benches:[**Any of the following species and grades:**]

1. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
2. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
3. Redwood, [**Heart Clear**][**Heart B or Select Heart**]; RIS.
4. Southern pine, [**Edge Grain B & B finish**][**Near Rift B & B finish**][**B & B finish**]; SPIB.

C. Radius-Edged Boards for Benches: [**Ipe**][**Teak**] S4S boards, [**same grade as decking**][**clear**][**clear all heart**][**, straight grained and parallel cut**].

2.6 DIMENSION LUMBER FRAMING

A. Deck and Stair Framing:

1. [**Select Structural**][**No. 1**][**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] grade and[**any of**] the following species:

   a. Hem-fir (North); NLGA.
   b. Southern pine; SPIB.
   c. Douglas fir-larch; WCLIB or WWPA.
   d. Mixed southern pine; SPIB.
   e. Spruce-pine-fir; NLGA.
   f. Douglas fir-south; WWPA.
   g. Hem-fir; WCLIB or WWPA.
   h. Douglas fir-larch (North); NLGA.
   i. Spruce-pine-fir (South); NeLMA, WCLIB, or WWPA.

2. Any species and grade with a modulus of elasticity of at least [**1,500,000 psi (10 350 MPa)**][**1,300,000 psi (8970 MPa)**][**1,100,000 psi (7590 MPa)**][**1,000,000 psi (6900 MPa)**][**900,000 psi (6210 MPa)**] and an extreme fiber stress in bending of at least [**1000 psi (6.9 MPa)**][**850 psi (5.86 MPa)**][**700 psi (4.83 MPa)**][**600 psi (4.14 MPa)**][**500 psi (3.45 MPa)**] for **2-inch nominal (38-mm actual)** thickness and **12-inch nominal (286-mm actual)** width for single-member use.

2.7 POSTS

A. Dimension Lumber Posts: [**No. 2**][**Construction or No. 2**][**Construction, Stud, or No. 3**] grade and[**any of**] the following species:

1. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
2. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
3. Mixed southern pine; SPIB.
4. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.
5. Northern species; NLGA.
6. Eastern softwoods; NeLMA.
7. Western woods; WCLIB or WWPA.

B. Timber Posts:

1. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); [**No. 1**][**No. 2**]; NeLMA, NLGA, SPIB, WCLIB, or WWPA.
2. Alaska cedar; [**No. 1**][**No. 2**]; WCLIB.
3. Southern pine; [**No. 1**][**No. 2**]; SPIB.

C. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200, with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

2.8 PRESERVATIVE-TREATED LUMBER

A. Pressure treat boards and dimension lumber with waterborne preservative in accordance with AWPA U1; Use Category UC3b[**for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground**].

B. Pressure treat timber with waterborne preservative in accordance with AWPA U1; Use Category UC4a.

C. Pressure treat poles with waterborne preservative in accordance with AWPA U1; Use Category UC4a.

D. Preservative Chemicals: Acceptable to authorities having jurisdiction.

1. Do not use chemicals containing arsenic or chromium [**except for timber posts**][**except for poles**].

E. Use process[**for boards and dimension lumber**] that includes water-repellent treatment.

F. Use process[**for boards and dimension lumber**] that does not include water repellents or other substances that might interfere with application of indicated finishes.

G. After treatment, redry [**boards**][**dimension lumber**][**timber**][**and**][**poles**] to 19 percent maximum moisture content.

H. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For items indicated to receive a stained or natural finish, [**mark each piece on surface that will not be exposed**][**or**][**omit marking and provide certificates of treatment compliance issued by inspection agency**].

I. Application: [**Treat all wood unless otherwise indicated.**][**Treat items indicated on Drawings and the following:**]

1. Framing members[**less than 18 inches (460 mm) above grade**].
2. Sills and ledgers.
3. Members in contact with masonry or concrete.
4. Posts.
5. Round wood poles.
6. Decking.
7. Stair treads.

2.9 PLASTIC DECKING

A. Plastic Lumber, General: Products acceptable to authorities having jurisdiction with current model code evaluation reports that show compliance with building code in effect for Project for indicated type of construction.

1. Allowable loads and spans, as documented in evaluation reports or in information referenced in evaluation reports, are not to be less than design loads and spans indicated.

B. Composite Plastic Lumber: [**Solid**][**or**][**hollow**] shapes made from a mixture of cellulose fiber and polyethylene or polypropylene.

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

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Fiberon**]
    c. [**Green Bay Decking, LLC**]
    d. [**Midwest Manufacturing**]
    e. [**MoistureShield; Oldcastle APG, Inc., CRH Americas, Inc.**]
    f. [**NewTechWood America, Inc.**]
    g. [**TimberTech, AZEK Building Products; The AZEK Company LLC**]
    h. [**Trex Company, Inc.**]
    i. [**UFP Construction; a UFP Industries Company**]

2. Decking Standard: [**ICC-ES AC109**][**or**][**ICC-ES AC174**].
3. Decking Size: [**7/8 by 5-1/2 inches (22 by 140 mm) actual**][**1-1/4 by 6 nominal, 1 by 5-1/2 inches (25 by 140 mm) actual**][**1-1/2 by 6 nominal, 1-1/4 by 5-1/2 inches (32 by 140 mm) actual**][**1-1/4 by 6 inches (32 by 152 mm) actual**][**1-3/8 by 3-1/2 inches (35 by 89 mm) actual**][**1-3/8 by 5-1/2 inches (35 by 140 mm) actual**][**2 by 6 nominal, 1-1/2 by 5-1/2 inches (38 by 140 mm) actual**].
4. Configuration: Provide product with grooved edges designed for fastening with concealed decking fasteners.
5. Surface Texture: [**Woodgrain**][**Smooth**][**Manufacturer's standard**].
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

C. All-Plastic Lumber: [**Solid**][**or**][**hollow**] shapes made from high-density polyethylene (HDPE), PVC, polystyrene, or cellular PVC with no cellulose fiber.

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

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Genova Products, Inc.**]
    c. [**Interplast Group, Ltd.**]
    d. [**L.B. Plastics, Inc.**]
    e. [**Re-Plast Products, Inc.**]
    f. [**RENEW Plastics, a division of N.E.W. Plastics Corp**]
    g. [**Veka Inc.**]
    h. [**Westech**]

2. Decking Standard: ICC-ES AC174.
3. Decking Size: [**1 by 6 inches (25 by 152 mm) actual**][**1-1/4 by 6 nominal, 1 by 5-1/2 inches (25 by 140 mm) actual**][**1-1/2 by 6 nominal, 1-1/4 by 5-1/2 inches (32 by 140 mm) actual**][**2 by 4 nominal, 1-1/2 by 3-1/2 inches (38 by 89 mm) actual**][**2 by 6 nominal, 1-1/2 by 5-1/2 inches (38 by 140 mm) actual**][**1-5/8 by 5-3/4 inches (41 by 146 mm) actual**].
4. Configuration: Provide product with [**grooved edges designed for fastening with concealed decking fasteners**][**or**][**tongue-and-groove edges designed for concealed fastening**].
5. Surface Texture: [**Woodgrain**][**Smooth**][**Manufacturer's standard**].
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

2.10 FASTENERS

A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.

1. Use [**stainless steel**][**fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329**] unless otherwise indicated.
2. For pressure-preservative-treated wood, use stainless steel fasteners.
3. For [**plastic**][**wood**] decking, use stainless steel fasteners[**where fasteners are exposed to view**].
4. For redwood, use [**brass/bronze**][**stainless steel**][**hot-dip galvanized-steel**] fasteners.

B. Nails: ASTM F1667.

C. Power-Driven Fasteners: ICC-ES AC70.

D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.

E. Carbon-Steel Bolts: **ASTM A307 (ASTM F568M)** with **ASTM A563 (ASTM A563M)** hex nuts and, where indicated, flat washers all hot-dip zinc coated.

F. Stainless Steel Bolts: **ASTM F593, Alloy Group 1 or 2 (ASTM F738M, Grade A1 or Grade A4)**; with **ASTM F594, Alloy Group 1 or 2 (ASTM F836M, Grade A1 or Grade A4)** hex nuts and, where indicated, flat washers.

G. Postinstalled Anchors: Stainless steel, [**chemical**][**or**][**torque-controlled expansion**] anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing in accordance with ASTM E488 conducted by a qualified independent testing and inspecting agency.

1. Stainless steel bolts and nuts complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or Grade A4)**.

2.11 METAL FRAMING ANCHORS

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

1. [**Tamlyn**]
2. [**USP Structural Connectors**]

B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those [**indicated on Drawings**][**of products of manufacturers listed**]. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, [**G60 (Z180)**][**G90 (Z270)**][**G185 (Z550)**] coating designation.

D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 316**].

E. Joist Hangers: U-shaped, with **2-inch- (50-mm-)** long seat and **1-1/4-inch- (32-mm-)** wide nailing flanges at least 85 percent of joist depth.

1. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].

F. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.

1. Strap Width: [**1-1/2 inches (38 mm)**][**2 inches (50 mm)**].
2. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].

G. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post **1 inch (25 mm)** above base and with **2-inch- (50-mm-)** minimum side cover, socket **0.062 inch (1.6 mm)** thick, and standoff and adjustment plates **0.108 inch (2.8 mm)** thick.

H. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

1. Width: [**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**].
2. Thickness: [**0.050 inch (1.3 mm)**][**0.062 inch (1.6 mm)**].
3. Length: [**16 inches (400 mm)**][**24 inches (600 mm)**][**As indicated**].

2.12 CONCEALED DECKING FASTENERS

A. Deck Splines: Corrosion-resistant metal or plastic splines that fit in grooves routed into the sides of decking material and are fastened to deck framing with screws. Splines provide uniform spacing of decking material.

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

a. [**Grabber Construction Products, Inc.**]
b. [**Ipe Clip Fastener Company Inc. (The)**]
c. [**M. M. Products, Inc.**]
d. [**Titan Metal Werks, Inc.**]

B. Deck Clips: Black-oxide-coated, stainless steel clips designed to be fastened to deck framing with screws, and to secure decking material with teeth that also provide uniform spacing of decking material.

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

a. [**FastenMaster; a division of OMG, Inc.**]

C. Deck Tracks: Formed metal strips designed to be fastened to deck framing and to secure decking material from underside with screws. Made from epoxy-powder-coated, hot-dip galvanized steel or stainless steel.

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

    a. [**Grabber Construction Products, Inc.**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Prime wood[**indicated to be painted**], including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Section 099113 "Exterior Painting."

C. Stain wood[**indicated to be stained**], including both faces and edges. Cut to required lengths and stain ends. Comply with requirements in Section 099300 "Staining and Transparent Finishing."

3.3 INSTALLATION, GENERAL

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.

B. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.

C. Install wood decking[**and stair treads**] with crown up (bark side down).

D. Install plastic lumber to comply with manufacturer's written instructions.

E. Secure decking to framing with [**deck splines**][**deck clips**][**deck tracks**][**or**][**screws**].

F. Install metal framing anchors to comply with manufacturer's written instructions.

G. Do not splice structural members between supports unless otherwise indicated.

H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

I. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

J. Apply copper naphthenate field treatment to comply with AWPA M4, to cut surfaces of preservative-treated lumber.

K. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. ICC-ES AC70 for power-driven fasteners.
2. "Fastening Schedule" in ICC's International Building Code.
3. "Fastener Schedule for Structural Members" and "Alternate Attachments" in ICC's International Residential Code for One- and Two-Family Dwellings.

L. Use common wire nails unless otherwise indicated. Select fasteners of size that do not fully penetrate members where opposite side is exposed to view. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.

M. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced and with adjacent rows staggered.

3.4 INSTALLATION OF ELEVATED DECK JOIST FRAMING

A. General: Install joists with crown edge up and support ends of each member with not less than **1-1/2 inches (38 mm)** of bearing on wood or metal, or **3 inches (76 mm)** on masonry. Attach floor joists where framed into wood supporting members by using wood ledgers as indicated or, if not indicated, by using metal joist hangers. Do not notch joists.

B. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds **48 inches (1200 mm)**.

C. Lap members framing from opposite sides of beams or girders not less than **4 inches (102 mm,)** or securely tie opposing members together. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist over supports.

D. Provide solid blocking of **2-inch nominal (38-mm actual)** thickness by depth of joist at intervals of **96 inches (2438 mm)** o.c., between joists.

3.5 INSTALLATION OF STAIRS

A. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:

1. Stringer Size: **2 by 12 inches nominal (38 by 286 mm actual)**, minimum.
2. Notching: Notch stringers to receive treads, risers, and supports; leave at least **3-1/2 inches (89 mm)** of effective depth.
3. Stringer Spacing: At least three stringers for each **36-inch (914-mm)** clear width of stair.

B. Provide stair framing with no more than[**3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than**] **3/8-inch (9.5-mm)** variation between largest and smallest treads and risers within each flight.

C. Treads and Risers: Secure by gluing and [**nailing**][**screwing**] to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages[**and finish with bullnose edge**].

3.6 INSTALLATION OF RAILINGS

A. Balusters: Fit to railings, [**glue, and**][**nail**][**screw**] in place. Countersink fastener heads, fill flush, and sand filler.

B. Newel Posts: Secure to stringers and risers with [**through bolts**][**lag screws**][**countersunk-head wood screws and glue**].

C. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts[**and glue**].

END OF SECTION 06 15 00 00A

Task	Specification	Specification Description
06 15 13 00	06 10 00 00	Rough Carpentry
06 15 13 00	06 15 00 00	Wood Roof Decking
06 15 13 00	06 15 00 00a	Wood Patio Decking

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SECTION 06 16 00 00 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.
3. Parapet sheathing.
4. Composite nail base insulated roof sheathing.
5. Subflooring.
6. Underlayment.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for plywood backing panels.
2. Section 072500 "Weather Barriers" for water-resistive barrier applied over wall sheathing.

1.2 DEFINITIONS

A. ABAA: The Air Barrier Association of America.

1.3 PREINSTALLATION MEETINGS

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

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical

data and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.

1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

C. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Laboratory Test Reports: For composite wood products, indicating compliance with the formaldehyde emissions evaluation.
4. Product Data: For installation adhesives, indicating VOC content.
5. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer [**including list of ABAA-certified installers and supervisors employed by Installer, who work on Project**][**and**][**testing and inspecting agency**] .

B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

D. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated plywood.
2. Fire-retardant-treated plywood.
3. Foam-plastic sheathing.
4. Air-barrier and water-resistant glass-mat gypsum sheathing.
5. Power-driven fasteners.

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

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.

1. Installer is to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and is to employ ABAA-certified installers and supervisors on Project.

B. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing meeting the requirements as follows:

    a. Independent agency, qualified in accordance with ASTM E329 for testing indicated, and certified by ABAA.

C. Certified Wood: Provide an invoice, including vendor's chain-of-custody number, product cost, and entity being invoiced.

D. Vendor Qualifications: Provide proof of use of vendors that are certified for chain of custody by an FSC-accredited certification body.

1.7 MOCKUPS

A. Build mockups to set quality standards for materials and execution [**and for preconstruction testing**], as directed by the Owner .

1. Build integrated mockups of exterior wall assembly [**as indicated on Drawings**][**150 sq. ft. (14 sq. m)**] , incorporating backup wall construction, window, storefront, door frame and sill, ties and other penetrations, and flashing to demonstrate crack and joint treatment and sealing of gaps, terminations, and penetrations of air-barrier sheathing assembly.

    a. Coordinate construction of mockups to permit inspection and testing of sheathing before external insulation and cladding are installed.
    b. Include junction with roofing membrane [**building corner condition,**][**and**][**foundation wall intersection**] .
    c. If Architect determines mockups do not comply with requirements, reconstruct mockups until mockups are approved, as directed by the Owner.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**the Owner will engage**][**Engage**] a qualified testing agency to perform preconstruction testing on field mockups, as directed by the Owner.

B. Mockup Testing: Air-barrier and water-resistant glass-mat gypsum sheathing assemblies are to comply with performance requirements, as evidenced by reports based on mockup testing by a qualified testing agency.

1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage in accordance with [**ASTM E1186, chamber pressurization or depressurization with smoke tracers**][**ASTM E1186, chamber depressurization with detection liquids**] .
2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate in accordance with [**ASTM E783**][**or**][**ASTM E2357**] .
3. Notify Architect [**seven**] days in advance of the dates and times when mockups will be tested, as directed by the Owner.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, are to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies are to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations [**tie-ins to installed waterproofing**][**tie-ins to other installed air barriers**] , and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.2 WOOD STRUCTURAL PANEL PRODUCTS

A. General: Wood structural panels include plywood, mat-formed (nonveneer) panels such as oriented strand board, and composite panels, which are veneer-faced panels with mat-formed cores.

B. Emissions: Products are to meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Certified Wood: Verify the following wood products are certified as "FSC Pure" [**or "FSC Mixed Credit"**] in accordance with FSC STD-01-001 and FSC STD-40-004.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

D. Certified Wood: Verify the following wood products are labeled in accordance with the AF&PA's Sustainable Forestry Initiative, certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004, or certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

E. Certified Wood: Verify the following wood products are certified in accordance with the American Tree Farm System's "ATFS 2021 Standards of Sustainability," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

F. Thickness: As needed to comply with requirements specified, but not less than thickness indicated on Drawings.

G. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative-Treated Plywood by Pressure Process: AWPA U1, use categories as follows:

1. UC2, Interior/Damp: For interior construction not in contact with ground but may be subject to moisture.
2. UC3B, Above Ground, Exposed: For exterior construction not in contact with ground, exposed to all weather cycles including prolonged wetting.
3. UC4A, Ground Contact: For wood panels in contact with ground and exposed to all weather cycles, normal exposure conditions.
4. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: [**Treat all plywood unless otherwise indicated**][**Treat items indicated on Drawings**][**and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing**] .

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 ft. (3.2 m)** beyond the centerline of the burners at any time during the test.

1. Treatment must not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated on Drawings.
3. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber plywood is to be tested in accordance with ASTM D5516 and design value adjustment factors are to be calculated in accordance with ASTM D6305. Span ratings after treatment are to be not less than span ratings specified. [**For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) are to be not less than span ratings specified.**]

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: [**Treat all plywood unless otherwise indicated.**][**Treat plywood indicated on Drawings, and the following:**]

1. Roof [**and wall**] sheathing within **48 inches (1220 mm)** of [**fire**][**party**] walls.
2. Roof sheathing.
3. Subflooring and underlayment for raised platforms.

2.5 WALL SHEATHING

A. Plywood Sheathing, Walls:

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**] .
3. Nominal Thickness: Not less than [**11/32 inch (8.7 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Walls:

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**] .
3. Nominal Thickness: Not less than [**5/16 inch (7.9 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (13 mm)**] .

C. Paper-Surfaced Gypsum Sheathing: ASTM C1396/C1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.

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

    a. [**American Gypsum**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Georgia-Pacific Gypsum LLC**]
    d. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Edge and End Configuration: [**V-shaped, tongue-and-groove long edges; square ends**][**Square**] .
4. Size: [**24 by 96 inches (610 by 2438 mm) for horizontal**][**48 by 96 inches (1219 by 2438 mm) for vertical**][**48 by 108 inches (1219 by 2743 mm) for vertical**][**600 by 2400 mm for horizontal**][**1200 by 2400 mm for vertical**][**1200 by 2750 mm for vertical**] installation.

D. Glass-Mat Gypsum Sheathing, Walls: ASTM C1177/C1177M.

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

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Continental Building Products Inc.**]
    c. [**Georgia-Pacific Gypsum LLC**]
    d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    e. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.

E. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, coated fiberglass mat gypsum sheathing with integral weather-resistant barrier and air barrier complying with ASTM E2178.

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

    a. [**Georgia-Pacific Gypsum LLC**]
    b. [**Tremco Commercial Sealants and Waterproofing, part of Tremco CPG**]
    c. [**USG Corporation**]

2. Thickness: **5/8 inch (15.9 mm)** thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.
4. Edges: Square.
5. Flashing and Transitions Strips: As acceptable to sheathing manufacturer.
6. Air Permeance: Maximum [**0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa)**] pressure difference when tested in accordance with ASTM E2178.
7. Vapor Permeance: Minimum [**20 perms (580 ng/Pa x s x sq. m)**] when tested in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.
8. Sheathing Assembly Air Leakage: Maximum [**0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa)**] when tested in accordance with ASTM E2357.
9. Fire Propagation Characteristics: Complies with NFPA 285 testing as part of an approved assembly.
10. UV Resistance: Can be exposed to sunlight for [**30**][**90**][**180**] days in accordance with manufacturer's written instructions.
11. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by sheathing manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

F. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C1278/C1278M, gypsum sheathing.

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

   a. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] .

G. Cementitious Backer Units, Walls: ASTM C1325, Type A.

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

   a. [**C-Cure**]
   b. [**Custom Building Products**]
   c. [**FinPan, Inc.**]
   d. [**USG Corporation**]

2. Thickness: [**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**] .

H. Fiberboard Sheathing: ASTM C208, Type IV, cellulosic fiberboard sheathing with square edges.

1. Grade: [**1 (Regular)**][**2 (Structural)**] .
2. Thickness: [**1/2 inch (13 mm)**][**25/32 inch (20 mm)**] .

I. Extruded-Polystyrene-Foam Sheathing: ASTM C578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.

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

   a. [**DiversiFoam Products**]
   b. [**HydroBlok**]
   c. [**Kingspan Insulation LLC**]
   d. [**Owens Corning**]
   e. [**The Dow Chemical Company**]

2. Thickness: [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**] .
3. Flame Propagation Test: Materials and construction are to be tested in accordance with NFPA 285.

J. Foil-Faced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type I or Type II, Class 2, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings are to have a flame-spread index of

25 or less when tested individually.

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

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Carlisle Coatings & Waterproofing Inc**]
    c. [**Elevate; Amrize Building Envelope LLC**]
    d. [**Hunter Panels; a Carlisle Company**]
    e. [**Rmax, A Business Unit of Sika Corporation**]
    f. [**The Dow Chemical Company**]

2. Thickness: [**7/16 inch (11.1 mm)**][**1/2 inch (13 mm)**][**5/8 inch (15.9 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**As indicated on Drawings**] .
3. Flame Propagation Test: Materials and construction are to be tested in accordance with NFPA 285.

2.6 ROOF SHEATHING

A. Plywood Sheathing, Roofs :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Roofs :

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**7/16 inch (11.1 mm)**][**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] .

2.7 PARAPET SHEATHING

A. Plywood Sheathing, Parapets :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**] .

B. Oriented-Strand-Board Sheathing, Parapets :

1. Classification: DOC PS 2, [**Exposure 1, Structural I**][**Exposure 1**] sheathing.
2. Span Rating: Not less than [**16/0**][**20/0**][**24/0**][**24/16**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**7/16 inch (11.1 mm)**][**15/32 inch (11.9 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**][**3/4 inch (19 mm)**] .

C. Glass-Mat Gypsum Roof Boards, Parapets: ASTM C1177/C1177M.

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

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**USG Corporation**]

2. Type and Thickness: [**Regular, 1/2 inch (13 mm)**][**Type X, 5/8 inch (15.9 mm)**] thick.
3. Size: [**48 by 96 inches (1219 by 2438 mm)**][**48 by 108 inches (1219 by 2743 mm)**][**48 by 120 inches (1219 by 3048 mm)**][**1200 by 2400 mm**][**1200 by 2750 mm**][**1200 by 3050 mm**] for vertical installation.

D. Cementitious Backer Units, Parapets: ASTM C1325, Type A.

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

    a. [**C-Cure**]
    b. [**Custom Building Products**]
    c. [**FinPan, Inc.**]
    d. [**USG Corporation**]

2. Thickness: [**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**] .

2.8 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type V with DOC PS 2, Exposure 1 oriented strand board on one face.

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

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Cornell Performance Building Products, a Subsidiary of GAF**]
    c. [**Hunter Panels; a Carlisle Company**]
    d. [**Johns Manville; a Berkshire Hathaway company**]
    e. [**Rmax, A Business Unit of Sika Corporation**]
    f. [**The Dow Chemical Company**]

2. Polyisocyanurate-Foam Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**] .
3. Oriented-Strand-Board Nominal Thickness: [**7/16 inch (11.1 mm)**][**5/8 inch (15.9 mm)**] .

B. Vented, Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type II,

Class 1, with DOC PS 2, Exposure 1 oriented strand board adhered to spacers on one face.

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

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Cornell Performance Building Products, a Subsidiary of GAF**]
    c. [**Hunter Panels; a Carlisle Company**]
    d. [**Johns Manville; a Berkshire Hathaway company**]
    e. [**Rmax, A Business Unit of Sika Corporation**]
    f. [**The Dow Chemical Company**]

2. Polyisocyanurate-Foam Thickness: [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**][**3-1/2 inches (89 mm)**][**4 inches (102 mm)**] .
3. Oriented-Strand-Board Nominal Thickness: [**7/16 inch (11.1 mm)**][**5/8 inch (15.9 mm)**] .
4. Spacers: Wood furring strips or blocks not less than **3/4 inch (19 mm)** thick and spaced not more than [**12 inches (300 mm)**][**16 inches (400 mm)**][**24 inches (600 mm)**] o.c.

2.9 SUBFLOORING

A. Plywood Combination Subfloor-Underlayment :

1. Classification: DOC PS 1, [**Exterior, Structural I, C-C Plugged**][**Exterior, C-C Plugged**][**Exposure 1, Structural I, Underlayment**][**Exposure 1, Underlayment**] single-floor panels.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .
4. Edge Detail: [**Square**][**Tongue and groove**] .
5. Surface Finish: Fully sanded face.

B. Oriented-Strand-Board Combination Subfloor-Underlayment :

1. Classification: DOC PS 2, Exposure 1 single-floor panels.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .
4. Edge Detail: [**Square**][**Tongue and groove**] .
5. Surface Finish: [**Fully sanded**][**Resin-impregnated overlay**] face.

C. Plywood Subflooring :

1. Classification: [**DOC PS 1**][**Either DOC PS 1 or DOC PS 2**] , [**Exterior, Structural I**][**Exterior**][**Exposure 1, Structural I**][**Exposure 1**] single-floor panels or sheathing.
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**][**or**][**32/16**][**40/20**][**48/24**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .

D. Oriented-Strand-Board Subflooring :

1. Classification: DOC PS 2, Exposure 1 [**Structural I sheathing**][**single-floor panels or sheathing**] .
2. Span Rating: Not less than [**16**][**20**][**24**][**32**][**48**][**or**][**32/16**][**40/20**][**48/24**][**60/32**] .
3. Nominal Thickness: Not less than [**23/32 inch (18.3 mm)**][**7/8 inch (22.2 mm)**][**1 inch (25 mm)**] .

2.10 UNDERLAYMENT

A. General: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than **1/4 inch (6.4 mm)** over smooth subfloors and not less than **3/8 inch (9.5 mm)** over board or uneven subfloors.

B. Plywood Underlayment for Resilient Flooring :

1. Classification: DOC PS 1, [**Exterior A-C**][**Exterior B-C**][**Exterior, C-C Plugged**][**Exposure 1 Underlayment**] with fully sanded face.

C. Plywood Underlayment for Ceramic Tile :

1. Classification: DOC PS 1, Exterior, C-C Plugged, not less than **5/8-inch (15.9-mm)** nominal thickness.

D. Plywood Underlayment for Carpet :

1. Classification: DOC PS 1, [**Exterior, C-C Plugged**][**Exposure 1, Underlayment**][**Interior, Underlayment**] .

E. Particleboard Underlayment : ANSI A208.1, [**Grade PBU**][**Grade M-2**] .

1. Verify particleboard is made without urea formaldehyde.
2. Verify particleboard has formaldehyde emission rates not greater than 0.09 ppm when tested in accordance with ASTM D6007 or ASTM E1333.

F. Hardboard Underlayment : ANSI A135.4, Class 4 (Service), Surface S1S; with back side sanded.

2.11 MISCELLANEOUS MATERIALS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacturer.

1. For [**roof**][**parapet**][**and**][**wall**] sheathing, provide fasteners [**with hot-dip zinc coating complying with ASTM A153/A153M**][**of Type 304 stainless steel**] .
2. For [**roof**][**parapet**][**and**][**wall**] sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended in writing by screw manufacturer for material being fastened.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended in writing by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than **0.0329 inch (0.835 mm)** thick, use screws that comply with ASTM C1002.
2. For steel framing from **0.033 to 0.112 inch (0.84 to 2.84 mm)** thick, use screws that comply with ASTM C954.

G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended in writing by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

H. Sealant for Paper-Surfaced and Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended in writing by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."

I. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended in writing by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum **2 inches (50 mm)** wide, **10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m)**, of type recommended in writing by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

J. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended in writing by sheathing manufacturer for sealing joints and penetrations in sheathing.

K. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with [**APA AFG-01**][**ASTM D3498**] that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

1. Verify adhesive has a VOC content of [**50**][**70**] g/L or less.
2. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in the ICC's "International Building Code."
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's "International Residential Code for One- and Two-Family Dwellings."
3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate [**wall**][**parapet**][**and**][**roof**] sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 INSTALLATION OF WOOD STRUCTURAL PANELS

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:

1. Combination Subfloor-Underlayment:

a. [**Glue and nail**][**Nail**] to wood framing.
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

2. Subflooring:

a. [**Glue and nail**][**Nail**][**Nail or staple**] to wood framing.
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

3. Wall and Roof Sheathing:

a. [**Nail**][**Nail or staple**] to wood framing. [**Apply a continuous bead of glue to framing members at edges of wall sheathing panels.**]
b. Screw to cold-formed metal framing.
c. Space panels **1/8 inch (3 mm)** apart at edges and ends.

4. Underlayment:

a. [**Nail**][**Nail or staple**] to subflooring.

b. Space panels **1/32 inch (0.8 mm)** apart at edges and ends.
c. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.

3.3 INSTALLATION OF GYPSUM SHEATHING

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to wood framing with [**nails**][**or**][**screws**] .
2. Fasten gypsum sheathing to cold-formed metal framing with screws.
3. Install panels with a **3/8-inch (9.5-mm)** gap where non-load-bearing construction abuts structural elements.
4. Install panels with a **1/4-inch (6.4-mm)** gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately **8 inches (200 mm)** o.c. and set back a minimum of **3/8 inch (9.5 mm)** from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately **8 inches (200 mm)** o.c. and set back a minimum of **3/8 inch (9.5 mm)** from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

E. Seal sheathing joints in accordance with sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.4 INSTALLATION OF AIR-BARRIER AND WATER-RESISTANT GLASS-MAT GYPSUM SHEATHING

A. Install accessory materials in accordance with sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.

1. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

2. Install transition strip on roofing membrane or base flashing, so that a minimum of **3 inches (75 mm)** of coverage is achieved over each substrate.

B. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

D. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply [**transition strip**][**preformed silicone extrusion**] , so that a minimum of **3 inches (75 mm)** of coverage is achieved over each substrate. Maintain **3 inches (75 mm)** of full contact over solid bearing to perimeter frames, with not less than **1 inch (25 mm)** of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.
2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

E. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.

F. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

G. Seal top of through-wall flashings to sheathing with an additional **6-inch- (150-mm-)** wide transition strip.

H. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

I. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending **6 inches (150 mm)** beyond repaired areas in strip direction.

3.5 INSTALLATION OF CEMENTITIOUS BACKER UNITS

A. Install panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.6 INSTALLATION OF FIBERBOARD SHEATHING

A. Comply with ASTM C846 and with manufacturer's written instructions.

B. Fasten fiberboard sheathing panels to intermediate supports and then at edges and ends. Use galvanized roofing nails [**or galvanized staples**] ; comply with manufacturer's recommended spacing and referenced fastening schedule. Drive fasteners flush with surface of sheathing and locate perimeter fasteners at least **3/8 inch (9.5 mm)** from edges and ends.

C. Install sheathing vertically with long edges parallel to, and centered over, studs. Install solid wood blocking where end joints do not occur over framing. Allow **1/8-inch (3-mm)** open space between edges

and ends of adjacent units. Stagger horizontal joints if any.

D. Cover sheathing as soon as practical after installation to prevent deterioration from wetting.

3.7 INSTALLATION OF FOAM-PLASTIC SHEATHING

A. Comply with manufacturer's written instructions.

B. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of moisture vapor that otherwise would be trapped in stud cavity behind sheathing.

C. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

3.8 INSTALLATION OF PARTICLEBOARD UNDERLAYMENT

A. Comply with CPA's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.

1. Fastening Method: [**Glue and nail**][**Nail**][**Nail or staple**] underlayment to subflooring.

3.9 INSTALLATION OF HARDBOARD UNDERLAYMENT

A. Comply with CPA's recommendations and hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.

1. Fastening Method: [**Nail**][**Nail or staple**] underlayment to subflooring.

3.10 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing and Inspecting Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. [**Inspections may include the following:**]

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
3. Termination mastic has been applied on cut edges.
4. Strips and transition strips have been firmly adhered to substrate.
5. Compatible materials have been used.
6. Transitions at changes in direction and structural support at gaps have been provided.
7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
8. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage in accordance with [**ASTM E1186, chamber pressurization or depressurization with smoke tracers**][**ASTM E1186, chamber depressurization using detection liquids**] .
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with [**ASTM E783**][**or**][**ASTM E2357**] .

E. Air barriers will be considered defective if they do not pass tests and inspections.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

END OF SECTION 06 16 00 00

Task	Specification	Specification Description
06 16 23 00	06 10 00 00	Rough Carpentry
06 16 23 00	06 16 00 00	Sheathing
06 16 33 00	06 10 00 00	Rough Carpentry
06 16 33 00	06 16 00 00	Sheathing
06 16 43 00	06 10 00 00	Rough Carpentry
06 16 43 00	06 16 00 00	Sheathing

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SECTION 07 62 00 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet metal materials.
2. Underlayment.
3. Miscellaneous materials.
4. Roof-drainage sheet metal fabrications.
5. Sloped roof sheet metal fabrications.
6. Wall sheet metal fabrications.
7. Miscellaneous sheet metal fabrications.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.
3. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
4. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
5. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
6. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies subject to vehicular traffic.

1.2 PREINSTALLATION MEETINGS

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

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For sheet metal flashing and trim.

1. Plans, elevations, sections, and attachment details.
2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.

3. Identification of material, thickness, weight, and finish for each item and location in Project.
4. Details for forming, including profiles, shapes, seams, and dimensions.
5. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Details of termination points and assemblies.
7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Details of roof-penetration flashing.
9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Details of special conditions.
11. Details of connections to adjoining work.
12. Formed flashing and trim at scale of not less than **1-1/2 inches per 12 inches (1:10)**.

C. Samples: For each exposed product and for each color and texture specified, **12 inches (300 mm)** long by actual width.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

E. Samples for Verification: Actual sample of finished products for each type of exposed finish for sheet metal and other metal accessories.

1. Sheet Metal Flashing and Trim: [**Manufacturers' standard size**] . Include finished seam with required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For each type of coping and roof edge flashing that is [**ANSI/SPRI/FM 4435/ES-1 tested**][**FM Approvals approved**] .

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For copings and roof edge flashing, from [**an agency acceptable to authority having jurisdiction**][**ICC-ES**] showing compliance with ANSI/SPRI/FM 4435/ES-1.

D. Qualification Statements: For fabricator.

E. Sample Warranties: For specified special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers**] .

C. For roof edge flashings and copings that are ANSI/SPRI/FM 4435/ES-1 tested [**and FM Approvals approved**] , shop is to be listed as able to fabricate required details as tested and approved.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof [**edge**][**eave**] , including [**built-in gutter**][**fascia**][**fascia trim**][**apron flashing**], approximately [**10 ft. (3.0 m)**] long, including supporting construction cleats, seams, attachments, [**underlayment,**] and accessories.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [**20**][**10**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with [**NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing"**][**SMACNA's "Architectural Sheet Metal Manual"**] requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Design Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. SPRI Wind Design Standard: Manufacture and install roof edge flashings and copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

   1. Design Pressure: [**As indicated on Drawings**] .

E. FM Approvals Listing: Manufacture and install roof edge flashings and copings that comply with requirements in FM Approvals 4471 as part of a roofing system and that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**]. Identify materials with name of fabricator and design approved by FM Approvals.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

   1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 SHEET METAL MATERIALS

A. Sheet Metal Materials, General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality.

   1. Nominal Thickness: [**0.022 inch (0.56 mm)**][**0.028 inch (0.71 mm)**][**0.034 inch**

(0.86 mm)][0.040 inch (1.02 mm)][0.052 inch (1.32 mm)] .

2. Surface: [**Smooth, flat**][**Embossed**][**and mill phosphatized for field painting**][**and with manufacturer's standard clear acrylic coating on both sides**] .
3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    b. Three-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    c. Mica Fluoropolymer: Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    d. Metallic Fluoropolymer: Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    e. FEVE Fluoropolymer: Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.

C. Aluminum Sheet: ASTM B209/B209M, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Thickness: [**0.032 inch (0.81 mm)**][**0.040 inch (1.02 mm)**][**0.050 inch (1.27 mm)**][**0.063 inch (1.60 mm)**] .
2. Surface: [**Smooth, flat**][**Embossed**] .
3. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .
    c. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin

manufacturers' written instructions [**for seacoast and severe environments**] .

d. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

e. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [**for seacoast and severe environments**] .

f. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil (0.005 mm)** for primer and **0.8 mil (0.02 mm)** for topcoat.

4. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil (0.013 mm)**.
6. Clear Anodic Finish, Coil Coated: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
7. Color Anodic Finish, Coil Coated: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

    a. Color: [**Champagne**][**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].
    b. Color Range: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

8. As-Milled Finish: [**Mill**][**One-side bright mill**][**Standard one-side bright**][**Standard two-side bright**] .
9. Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.
10. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of **0.2 mil (0.005 mm)**.

D. Stainless Steel Sheet: ASTM A240/A240M, [**Type 304**][**Type 316**] ; dead soft, fully annealed.

1. Nominal Thickness: [**0.0156 inch (0.396 mm)**][**0.0188 inch (0.477 mm)**][**0.0250 inch (0.635 mm)**][**0.0313 inch (0.795 mm)**][**0.0375 inch (0.952 mm)**][**0.0500 inch (1.270 mm)**] .
2. Surface: [**Smooth, flat**][**Embossed**] .
3. Exterior Finish: [**ASTM A480/A480M, No. 2B (bright, cold rolled)**][**ASTM A480/A480M, No. 2D (dull, cold rolled)**][**ASTM A480/A480M, No. 3 (coarse, polished directional satin)**][**ASTM A480/A480M No. 4**].

    a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
    b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

        1) Run grain of directional finishes with long dimension of each piece.
        2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

E. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

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

   a. [**Hussey Copper Ltd.**]
   b. [**Revere Copper Products, Inc**]

2. Thickness: [**16 oz./sq. ft. (0.55 mm)**][**20 oz./sq. ft. (0.68 mm)**][**24 oz./sq. ft. (0.82 mm)**].
3. Nonpatinated, Exposed Finish: Mill.
4. Nonpatinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA AMP 500.

   a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.
   b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats in accordance with manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.

5. Prepatinated Copper-Sheet Finish: [**Dark brown**][**Verdigris**], prepatinated in accordance with ASTM B882.

F. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 temper; coated on both sides with zinc-tin alloy (50 percent zinc, 50 percent tin).

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

   a. [**Revere Copper Products, Inc**]

2. Thickness: [**16 oz./sq. ft. (0.55 mm thick)**][**20 oz./sq. ft. (0.68 mm thick)**][**24 oz./sq. ft. (0.82 mm thick)**][**25 oz./sq. ft. (0.87 mm thick)**] .

G. Zinc Sheet: With manufacturer's standard factory-applied, flexible, protective back coating.

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

   a. [**Artazn LLC**]
   b. [**Rheinzink America**]

2. Grade: [**99.995 percent electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent)**][**Zinc, 99**

percent pure, alloyed with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum] .

3. Thickness: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**][**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] .
4. Finish: [**Bright rolled**][**Preweathered gray**][**Preweathered black**].

H. Copper-Clad Stainless Steel Sheet: ASTM B506, annealed Temper O61.

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

    a. [**Heyco Metals**]
    b. [**SEMCO Southeastern Metals, A Gibraltar Industries Company**]

2. Thickness: [**0.016 inch (0.40 mm)**][**0.018 inch (0.46 mm)**][**0.027 inch (0.69 mm)**] .
3. Nonpatinated, Exposed Finish: Mill.
4. Nonpatinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with system defined in NAAMM/NOMMA AMP 500.

    a. Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.
    b. Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," [**waterborne,**][**solvent-borne,**] air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to total thickness of **1 mil (0.025 mm)**.

I. Lead Sheet: ASTM B749 lead sheet.

1. Thickness: **4 lb (1.8 kg)**.

2.3 UNDERLAYMENT

A. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over **220 deg F (111 deg C)**; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Intertape Polymer Group**]
    c. [**Kirsch Building Products**]
    d. [**SDP Advanced Polymer Products Inc.**]

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet

underlayment, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ATAS International, Inc.**]
    b. [**Carlisle WIP Products; a brand of Carlisle Construction Materials**]
    c. [**GCP Applied Technologies Inc.**]
    d. [**Henry; a Carlisle Company**]
    e. [**Owens Corning**]
    f. [**Polyglass U.S.A., Inc.**]
    g. [**Protecto Wrap Company**]
    h. [**SDP Advanced Polymer Products Inc.**]

2. Thickness: **30 mils (0.76 mm)** minimum.
3. Thermal Stability: Stable after testing at **240 deg F (116 deg C)**; ASTM D1970/D1970M.
4. Low-Temperature Flexibility: Passes after testing at **minus 20 deg F (minus 29 deg C)** or lower; ASTM D1970/D1970M.

C. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

D. Slip Sheet: Rosin-sized building paper, **3 lb/100 sq. ft. (0.16 kg/sq. m)** minimum, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners [**solder**] , protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal [**manufactured item**] unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal [**manufactured item**] .

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
    c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
5. Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet:

Copper, hardware bronze or passivated Series 300 stainless steel.

6. Fasteners for Zinc Sheet: Series 300 stainless steel [**or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M**] .

C. Solder:

1. For Zinc-Coated (Galvanized) Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead**][**with maximum lead content of 0.2 percent**] .
2. For Stainless Steel: ASTM B32, [**Grade Sn60**][**Grade Sn96**] , with acid flux of type recommended by stainless steel sheet manufacturer.
3. For Copper or Copper-Clad Stainless Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead**][**with maximum lead content of 0.2 percent**] .
4. For Zinc-Tin Alloy-Coated Copper: ASTM B32, 100 percent tin, with maximum lead content of 0.2 percent, as recommended by sheet metal manufacturer.
5. For Zinc: ASTM B32, [**40 percent tin and 60 percent lead with low antimony,**][**with maximum lead content of 0.2 percent,**] as recommended by zinc manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.

E. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

1. Material: [**Polyurethane**][**Polysulfide**][**Silicone**] .

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

J. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated [**with factory-mitered and -welded corners and junctions**][**with interlocking counterflashing on exterior face, of same metal as reglet**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Cheney Flashing Company**]
b. [**Fry Reglet Corporation**]
c. [**Heckmann Building Products, Inc.**]
d. [**Hohmann & Barnard, Inc**]
e. [**Keystone Flashing Company, Inc**]
f. [**Metal-Era, Inc.; a Carlisle Company**]
g. [**OMG Roofing Products; a Division of OMG, Inc.**]

2. Material: [**Galvanized steel, 0.022 inch (0.56 mm) thick**][**Aluminum, 0.024 inch (0.61 mm) thick**][**Stainless steel, 0.0188 inch (0.477 mm) thick**][**Copper, 16 oz./sq. ft. (0.55 mm thick)**] .
3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
5. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
7. Accessories:

    a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
    b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

8. Finish: [**Mill**][**With manufacturer's standard color coating**].

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard [**and by FM Global Property Loss Prevention Data Sheet 1-49**] for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. [**Rivet joints where necessary for strength.**]
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. [**Rivet joints where necessary for strength.**]

H. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.

1. Minimum Fabrication Length: **96-inch- (2400-mm-)** long sections.
2. Gutter Brackets, Spacers, and Straps: Furnish flat-stock gutter brackets and [**flat-stock**][**twisted**] gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than [**twice the gutter thickness**][**dimension indicated on Drawings**].
3. Gutter Components: Fabricate expansion joints, expansion-joint covers, [**gutter bead reinforcing bars,**] and gutter accessories from same metal as gutters. [**Shop fabricate interior and exterior corners.**]
4. Gutter Profile: [**Style A**][**Style B**][**Style C**][**Style D**][**Style E**][**Style F**][**Style G**][**Style H**][**Style I**][**Style J**][**Style K**][**Style L**] in accordance with cited sheet metal standard.
5. Expansion Joints: [**Lap type**][**Butt type**][**Butt type with cover plate**][**Built in**] .
6. Accessories: [**Continuous, removable leaf screen with sheet metal frame and hardware cloth screen**][**Wire-ball downspout strainer**][**Valley baffles**] .
7. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:

    a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
    c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
    d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

8. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:

    a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
    c. Aluminum: [**0.040 inch (1.02 mm)**] thick.
    d. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.039 inch (1.00 mm)**][**0.048 inch (1.25 mm)**] thick.

h. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

9. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.034 inch (0.86 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.034 inch (0.86 mm)**] thick.
c. Aluminum: [**0.050 inch (1.27 mm)**] thick.
d. Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
e. Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
g. Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

10. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
c. Aluminum: [**0.063 inch (1.60 mm)**] thick.
d. Stainless Steel: [**0.0313 inch (0.795 mm)**] thick.
e. Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].

11. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following materials:

a. Galvanized Steel: [**0.052 inch (1.32 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.052 inch (1.32 mm)**] thick.
c. Stainless Steel: [**0.0375 inch (0.952 mm)**] thick.
d. Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**25 oz./sq. ft. (0.87 mm thick)**].

B. Built-In Gutters: Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.

1. Minimum Fabrication Length: **96-inch- (2400-mm-)** long sections.
2. Gutter Components: Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
3. Expansion Joints: Fabricate gutters with built-in expansion joints [**and gutter-end expansion joints at walls**] .
4. Accessories: [**Continuous, removable leaf screen with sheet metal frame and hardware cloth screen**][**Bronze wire-ball downspout strainer**][**Wire-ball downspout strainer**] .
5. Fabricate from the following materials:

a. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
b. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
c. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
d. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
e. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

C. Downspouts: Fabricate downspouts to dimensions indicated on Drawings.

1. Type: [**Round**][**Rectangular**][**Open face**] .
2. Downspout Elbows: Mitered [**and shop fabricated**] .
3. Metal Hangers: Provide [**same material as downspouts and anchors**].
4. Fabricated Hanger Style: [**Fig. 1-35A**][**Fig. 1-35B**][**Fig. 1-35C**][**Fig. 1-35D**][**Fig. 1-35E**][**Fig. 1-35F**][**Fig. 1-35G**][**Fig. 1-35H**][**Fig. 1-35I**][**Fig. 1-35J**] in accordance with SMACNA's "Architectural Sheet Metal Manual."

5. Manufactured Hanger Style: [**Fig. 1-34A**][**Fig. 1-34B**][**Fig. 1-34C**][**Fig. 1-34D**][**Fig. 1-34E**] in accordance with SMACNA's "Architectural Sheet Metal Manual."
6. Fabricate from the following materials:

    a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
    c. Aluminum: [**0.024 inch (0.61 mm)**] thick.
    d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

D. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, **4-inch- (100-mm-)** wide wall flanges to interior, and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof. [**Fasten gravel guard angles to base of scupper.**]

1. Fabricate from the following materials:

    a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
    c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
    d. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

E. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes [**exterior flange trim,**][**built-in overflows**] .

1. Fabricate from the following materials:

    a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
    b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
    c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
    d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
    e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

F. Splash Pans: Fabricate to dimensions and shape required.

1. Fabricate from the following materials:

    a. Aluminum: [**0.040 inch (1.02 mm)**] thick.
    b. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
    c. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    d. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
    e. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
    f. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2.7 SLOPED ROOF SHEET METAL FABRICATIONS

A. Low-Sloped Roof Sheet Metal Fabrications:

1. Roof Edge Flashing (Gravel Stop) and Fascia Cap:

a. Fabricate in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long sections. Furnish with **6-inch- (150-mm-)** wide, joint cover plates. [**Shop fabricate interior and exterior corners.**]
b. Joint Style: [**Overlapped, 4 inches (100 mm) wide**][**Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate**][**Butted with expansion space and 6-inch- (150-mm-) wide, exposed cover plate**].
c. Scuppers: Fabricate with scuppers spaced [**10 ft. (3 m)**] apart, to dimensions required with **4-inch- (100-mm-)** wide flanges and base extending **4 inches (100 mm)** beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
d. Fabricate from the following materials:

1) Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**] .
7) Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2. Copings:

a. Fabricate in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and [**drill elongated holes for fasteners on**] interior leg. Miter corners, [**fasten and seal**][**solder or weld**] watertight. [**Shop fabricate interior and exterior corners.**]
b. Coping Profile: [**Fig. 3-4A**][**Fig. 3-4B**][**Fig. 3-4C**][**Fig. 3-4D**][**Fig. 3-4E**][**Fig. 3-4F**][**Fig. 3-4G**] in accordance with SMACNA's "Architectural Sheet Metal Manual."
c. Joint Style: [**Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate**][**Butted with expansion space and 6-inch- (150-mm-) wide, exposed cover plate**] .
d. Fabricate from the following materials:

1) Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
5) Copper: [**24 oz./sq. ft. (0.82 mm thick)**] .
6) Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
7) Zinc: [**0.048 inch (1.25 mm)**][**0.059 inch (1.50 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

3. Expansion-Joint Covers:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate [**roof**][**roof-to-wall transition**][**roof-to-roof edge-flashing (gravel-stop) transition**][**roof-to-roof edge-flashing (gravel-stop) and fascia-cap transition**] expansion-joint cover from the following materials:

1) Galvanized Steel: [**0.034 inch (0.86 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.034 inch (0.86 mm)**] thick.
3) Aluminum: [**0.050 inch (1.27 mm)**] thick.
4) Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

4. Base Flashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3) Aluminum: [**0.040 inch (1.02 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**20 oz./sq. ft. (0.68 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

5. Counterflashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
3) Aluminum: [**0.032 inch (0.81 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

6. Flashing Receivers: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

7. Roof-Penetration Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
c. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
d. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].

f. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
g. Copper-Clad Stainless Steel: [0.018 inch (0.46 mm)] thick.
h. Lead: [4 lb (1.8 kg)].

8. Roof-Drain Flashing: Fabricate from the following materials:

a. Stainless Steel: [0.0156 inch (0.396 mm)] thick.
b. Copper: [12 oz./sq. ft. (0.41 mm thick)].
c. Copper-Clad Stainless Steel: [0.016 inch (0.40 mm)] thick.

B. Steep-Slope Roof Sheet Metal Fabrications:

1. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:

a. Galvanized Steel: [0.022 inch (0.56 mm)] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch (0.56 mm)] thick.
c. Aluminum: [0.032 inch (0.81 mm)] thick.
d. Stainless Steel: [0.0156 inch (0.396 mm)] thick.
e. Copper: [16 oz./sq. ft. (0.55 mm thick)].
f. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft. (0.55 mm thick)].
g. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
h. Copper-Clad Stainless Steel: [0.016 inch (0.40 mm)] thick.

2. Valley Flashing: Fabricate from the following materials:

a. Galvanized Steel: [0.028 inch (0.71 mm)] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch (0.71 mm)] thick.
c. Stainless Steel: [0.0188 inch (0.477 mm)] thick.
d. Copper: [16 oz./sq. ft. (0.55 mm thick)].
e. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft. (0.55 mm thick)].
f. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
g. Copper-Clad Stainless Steel: [0.018 inch (0.46 mm)] thick.

3. Drip Edges: Fabricate from the following materials:

a. Galvanized Steel: [0.022 inch (0.56 mm)] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch (0.56 mm)] thick.
c. Aluminum: [0.032 inch (0.81 mm)] thick.
d. Stainless Steel: [0.0156 inch (0.396 mm)] thick.
e. Copper: [16 oz./sq. ft. (0.55 mm thick)].
f. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft. (0.55 mm thick)].
g. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
h. Copper-Clad Stainless Steel: [0.016 inch (0.40 mm)] thick.

4. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:

a. Galvanized Steel: [0.022 inch (0.56 mm)] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch (0.56 mm)] thick.
c. Aluminum: [0.032 inch (0.81 mm)] thick.
d. Stainless Steel: [0.0156 inch (0.396 mm)] thick.
e. Copper: [16 oz./sq. ft. (0.55 mm thick)].
f. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft. (0.55 mm thick)].
g. Zinc: [0.032 inch (0.80 mm)][0.039 inch (1.00 mm)] thick.
h. Copper-Clad Stainless Steel: [0.016 inch (0.40 mm)] thick.

5. Counterflashing:

a. General: [**Shop fabricate interior and exterior corners.**] Fabricate from the following materials:

1) Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
2) Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
3) Aluminum: [**0.032 inch (0.81 mm)**] thick.
4) Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5) Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6) Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
7) Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8) Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

6. Flashing Receivers: Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

7. Roof-Penetration Flashing: Fabricate from the following materials:

a. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
c. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
d. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
e. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
f. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
g. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.
h. Lead: [**4 lb (1.8 kg)**].

2.8 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing:

1. General: Fabricate continuous flashings in minimum **96-inch- (2400-mm-)** long, but not exceeding **12 ft. (3.6 m)** long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend **6 inches (150 mm)** beyond each side of wall openings; and form with **2-inch- (50-mm-)** high, end dams. Fabricate from the following materials:

a. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
b. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
c. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
d. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
e. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

B. Opening Flashings in Frame Construction:

1. General: Fabricate head, sill, [**jamb,**] and similar flashings to extend [**4 inches (100 mm)**] beyond wall openings. Form head and sill flashing with **2-inch- (50-mm-)** high, end dams.

Fabricate from the following materials:

a. Galvanized Steel: [**0.022 inch (0.56 mm)**] thick.
b. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch (0.56 mm)**] thick.
c. Aluminum: [**0.032 inch (0.81 mm)**] thick.
d. Stainless Steel: [**0.0156 inch (0.396 mm)**] thick.
e. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
f. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
g. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
h. Copper-Clad Stainless Steel: [**0.016 inch (0.40 mm)**] thick.

C. Wall Expansion-Joint Cover: Fabricate from the following materials:

1. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3. Aluminum: [**0.040 inch (1.02 mm)**] thick.
4. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
5. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
6. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
7. Zinc: [**0.032 inch (0.80 mm)**][**0.039 inch (1.00 mm)**] thick.
8. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Galvanized Steel: [**0.028 inch (0.71 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch (0.71 mm)**] thick.
3. Stainless Steel: [**0.0188 inch (0.477 mm)**] thick.
4. Copper: [**16 oz./sq. ft. (0.55 mm thick)**].
5. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft. (0.55 mm thick)**] .
6. Copper-Clad Stainless Steel: [**0.018 inch (0.46 mm)**] thick.

B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Galvanized Steel: [**0.040 inch (1.02 mm)**] thick.
2. Aluminum-Zinc Alloy-Coated Steel: [**0.040 inch (1.02 mm)**] thick.
3. Stainless Steel: [**0.0250 inch (0.635 mm)**] thick.
4. Copper: [**24 oz./sq. ft. (0.82 mm thick)**] .
5. Zinc-Tin Alloy-Coated Copper: [**24 oz./sq. ft. (0.82 mm thick)**].
6. Copper-Clad Stainless Steel: [**0.027 inch (0.69 mm)**] thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than **4 inches (100 mm)**.
2. Lap end joints not less than **12 inches (300 mm)**.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches (150 mm)** staggered **24 inches (600 mm)** between courses.
5. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than **2 inches (50 mm)**.

D. Slip Sheet: Install slip sheet, wrinkle free, [**over underlayment**][**directly on substrate**] before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than **4 inches (100 mm)**.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners [**solder**] , protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of [**solder**][**welds**][**sealant**] .
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than **12 inches (300 mm)** o.c.
6. Space individual cleats not more than **12 inches (300 mm)** apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.

8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of [**uncoated-aluminum**][**stainless steel**] sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of [**10 ft. (3 m)**] with no joints within **24 inches (600 mm)** of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws**][**substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance**].

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than **1 inch (25 mm)** into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below **40 deg F (4 deg C)**.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pretin edges of sheets with solder to width of **1-1/2 inches (38 mm)**; however, reduce pretinning where pretinned surface would show in completed Work.
2. Do not solder [**metallic-coated steel**][**aluminum**] sheet.
3. Do not pretin zinc-tin alloy-coated copper.
4. Do not use torches for soldering.
5. Heat surfaces to receive solder, and flow solder into joint.

a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

6. Stainless Steel Soldering:

    a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
    b. Promptly remove acid-flux residue from metal after tinning and soldering.
    c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.

H. Rivets: Rivet joints in [**uncoated aluminum**][**zinc**] where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:

1. Join sections with [**riveted and soldered joints**][**joints sealed with sealant**] .
2. Provide for thermal expansion.
3. Attach gutters at eave or fascia to firmly anchor them in position.
4. Provide end closures and seal watertight with sealant.
5. Slope to downspouts.
6. Fasten gutter spacers to front and back of gutter.
7. Anchor and loosely lock back edge of gutter to continuous [**cleat**][**eave or apron flashing**] .
8. Anchor back of gutter that extends onto roof deck with cleats spaced not more than [**24 inches (600 mm)**] apart.
9. Anchor gutter with [**gutter brackets**][**straps**][**twisted straps**] spaced not more than [**24 inches (600 mm)**][**30 inches (760 mm)**][**36 inches (910 mm)**] apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
10. Anchor gutter with spikes and ferrules spaced not more than [**24 inches (600 mm)**][**30 inches (760 mm)**] apart.
11. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, [**50 ft. (15.2 m)**] apart. Install expansion-joint caps.
12. Install continuous gutter screens on gutters with noncorrosive fasteners, [**removable**][**hinged to swing open**] for cleaning gutters.

C. Built-In Gutters:

1. Join sections with [**riveted and soldered joints**][**joints sealed with sealant**] .
2. Provide for thermal expansion.
3. Slope to downspouts.
4. Provide end closures and seal watertight with sealant.
5. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and under underlayment on roof sheathing.

    a. Lap sides minimum of **2 inches (50 mm)** over underlying course.
    b. Lap ends minimum of **4 inches (100 mm)**.
    c. Stagger end laps between succeeding courses at least **72 inches (1830 mm)**.
    d. Fasten with roofing nails.
    e. Install slip sheet over underlayment.

6. Anchor and loosely lock back edge of gutter to continuous [**cleat**][**eave or apron flashing**].
7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than [**18 inches (460 mm)**] apart.
8. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, [**50 ft. (15.2 m)**] apart. Install expansion-joint caps.

D. Downspouts:

1. Join sections with **1-1/2-inch (38-mm)** telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately **60 inches (1500 mm)** o.c.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

E. Parapet Scuppers:

1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
2. Anchor scupper closure trim flange to exterior wall and [**solder**][**seal with elastomeric sealant**] to scupper.
3. Loosely lock front edge of scupper with conductor head.
4. [**Solder**][**seal with elastomeric sealant**] exterior wall scupper flanges into back of conductor head.

F. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of **1 inch (25 mm)** below [**scupper**][**gutter**] discharge.

G. Splash Pans:

1. Install where downspouts discharge on [**low-slope roofs**].
2. Set in [**asphalt roofing cement**][**elastomeric sealant**] compatible with the substrate.

H. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of **4 inches (100 mm)** in direction of water flow.

3.5 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

A. Install sheet metal flashing and trim to comply with performance requirements [**sheet metal manufacturer's written installation instructions,**] and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at [**staggered 3-inch (75-mm)**] centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Install copings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.

    a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at [**24-inch (600-mm)**][**16-inch (400-mm)**] centers.
    b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at [**24-inch (600-mm)**] centers.

3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of **4 inches (100 mm)** over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing **4 inches (100 mm)** over base flashing.
3. Lap counterflashing joints minimum of **4 inches (100 mm)**.
4. Secure in waterproof manner by means of [**snap-in installation and sealant or lead wedges and sealant**][**interlocking folded seam or blind rivets and sealant**][**anchor and washer spaced at 12 inches (300 mm) o.c. along perimeter and 6 inches (150 mm) o.c. at corners areas**] unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with [**elastomeric**][**butyl**] sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL SHEET METAL FABRICATIONS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, [**jamb,**] and similar flashings to extend [**4 inches (100 mm)**] beyond wall openings.

C. Reglets: Installation of reglets is specified in [**Section 033000 "Cast-in-Place Concrete."**][**Section 042000 "Unit Masonry."**]

3.7 INSTALLATION OF MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing:

1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
2. Weld or seal flashing with elastomeric sealant to equipment support member.

B. Overhead-Piping Safety Pans:

1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

A. Shim and align sheet metal flashing and trim within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

A. Clean and neutralize flux materials. Clean off excess solder.

B. Clean off excess sealants.

3.10 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as directed by the Owner.

END OF SECTION 07 62 00 00

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Task	Specification	Specification Description
07 62 13 00	07 62 00 00	Sheet Metal Flashing And Trim
07 62 19 00	07 62 00 00	Sheet Metal Flashing And Trim

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SECTION 07 63 00 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes:

1. Motors.
2. Sleeves without waterstop.
3. Sleeves with waterstop.
4. Stack-sleeve fittings.
5. Sleeve-seal systems.
6. Grout.
7. Silicone sealants.
8. Escutcheons.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the fire-suppression equipment Sections.

a. Include construction details, material descriptions, and dimensions of components.
b. Include operating characteristics and furnished accessories.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft. (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Multispeed Motors, Multiple Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**]<**Insert class**>.
10. Code Letter Designation:

    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes [**324T**]<**Insert number**> and larger; rolled steel for motor frame sizes smaller than [**324T**]<**Insert number**>.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box,

suited to control method.

2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [**120 V**][**or**][**240 V**] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [**Circuit board**][**or**][**digital speed controller/LED display**].
4. Building Automation System Interface: Via [**AC voltage signal**][**DC voltage signal**][**or**][**Digital Serial Interface (DSI)**].

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge (0.6 mm)** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Advance Products & Systems, LLC**]
    b. [**CALPICO, Inc.**]
    c. [**GPT; a division of EnPRO Industries**]
    d. [**Metraflex Company (The)**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advance Products & Systems, LLC**]
    b. [**CALPICO, Inc.**]
    c. [**GPT; a division of EnPRO Industries**]
    d. [**Metraflex Company (The)**]
    e. <**Insert manufacturer's name**>

3. Description: Manufactured [**PVC/HDPE**][**steel**][**stainless steel**][**galvanized steel**], sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Wade; a subsidiary of McWane Inc.**]
    c. [**Zurn Industries, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
    b. [**Wade; a subsidiary of McWane Inc.**]
    c. [**Zurn Industries, LLC**]
    d. <**Insert manufacturer's name**>

3. Description: Manufactured, [**Dura-coated or Duco-coated**][**galvanized**] cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT; a division of EnPRO Industries**]
d. [**Metraflex Company (The)**]
e. [**Proco Products, Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**CALPICO, Inc.**]
c. [**GPT; a division of EnPRO Industries**]
d. [**Metraflex Company (The)**]
e. [**Proco Products, Inc**]
f. <**Insert manufacturer's name**>

3. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

a. Hydrostatic Seal: **20 psig (137 kPa)** minimum.
b. Sealing Elements: [**EPDM-rubber**][**High-temperature-silicone**][**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
c. Pressure Plates: [**Carbon steel**][**Composite plastic**][**Stainless steel**][**Stainless steel, Type 316**].
d. Connecting Bolts and Nuts: [**Carbon steel, with ASTM B633 coating**][**Stainless steel**][**Stainless steel, Type 316,**] of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
2) [**ITW Polymers Sealants North America**]
3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
4) [**Sherwin-Williams Company (The)**]

5) [**Sika Corporation**]
6) [**The Dow Chemical Company**]
7) [**Tremco Incorporated**]
8) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
2) [**ITW Polymers Sealants North America**]
3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
4) [**Sherwin-Williams Company (The)**]
5) [**Sika Corporation**]
6) [**The Dow Chemical Company**]
7) [**Tremco Incorporated**]
8) <**Insert manufacturer's name**>

c. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, [**25**][**100/50**], pourable, [**plus 25 percent and minus 25 percent**][**plus 100 percent and minus 50 percent**] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Pecora Corporation**]
2) [**Sika Corporation**]
3) [**The Dow Chemical Company**]
4) [**Tremco Incorporated**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Pecora Corporation**]
2) [**Sika Corporation**]
3) [**The Dow Chemical Company**]
4) [**Tremco Incorporated**]
5) <**Insert manufacturer's name**>

c. Standard: ASTM C920, Type S, Grade P, [**Class 25**][**Class 100/50**], Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Smooth-On**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Smooth-On**]
2) <**Insert manufacturer's name**>

4. Sealant shall have a VOC content of [**250**]<**Insert value**> g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.3 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7. <**Insert manufacturer's name**>

C. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**][**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**][**and**][**exposed-rivet**] hinge; and spring-clip fasteners.

D. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.2 INSTALLATION OF SLEEVES, GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch (25-mm)**][**2-inch (50-mm)**]<**Insert dimension**> annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches (50 mm)**]<**Insert dimension**> above finished floor level.

3. Using [**grout**][**or**][**silicone sealant**], seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire-resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width centered in concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [**grout**][**or**][**silicone sealant**], seal space around outside of sleeves.

3.4 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to **3 inches (75 mm)** above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.6 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.7 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.8 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**]<**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**]<**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [**Sleeves with waterstops**][**or**][**stack-sleeve fittings**].

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.9 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece[**, steel**][**, cast brass**][**or split plate steel**] with polished, chrome-plated finish.
3. Insulated Piping:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
    c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
    c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with

[**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.

6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

END OF SECTION 07 63 00 00

SECTION 07 63 00 00A - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Medical compressed-air packaged system.
2. Instrument compressed-air packaged system.
3. Air compressor packaged system - reciprocating, oil less.
4. Air compressor packaged system - liquid ring.
5. Air compressor packaged system - rotary screw.
6. Air compressor packaged system - scroll.
7. Air compressor packaged system - diaphragm.
8. Air filters - inlet type.
9. Compressed-air dryers - refrigerated.
10. Compressed-air dryers - desiccant.
11. Compressed-air purification systems.
12. Compressed-air filter assemblies.
13. Dental compressed-air packaged system.
14. Dental compressed-air system control panels.

1.2 DEFINITIONS

A. Actual Air: Air delivered at air compressor outlet. Flow rate is compressed air delivered and measured in **acfm (actual L/s)**.

B. Laboratory Air Equipment: Compressed-air equipment and accessories for laboratory facilities.

C. Medical Air Equipment: Compressed-air equipment and accessories for [**medical**][**dental**][**and**][**instrument**] compressed air for healthcare facilities.

D. Standard Air: Free air at **68 deg F (20 deg C)** and **1 atmosphere (29.92 in. Hg)** before compression or expansion and measured in **scfm (standard L/s)**.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Medical compressed-air packaged system.
2. Instrument compressed-air packaged system.
3. Air compressor packaged system - reciprocating, oil less.
4. Air compressor packaged system - liquid-ring.
5. Air compressor packaged system - rotary screw.
6. Air compressor packaged system - scroll.
7. Air compressor packaged system - diaphragm.
8. Air filters - inlet type.
9. Compressed-air dryers - refrigerated.
10. Compressed-air dryers - desiccant.

11. Compressed-air purification systems.
12. Compressed-air filter assemblies.
13. Dental compressed-air packaged system.
14. Dental compressed-air system control panels.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Diagrams for power, signal, and control wiring.

D. Delegated Design Submittals:

1. Detail fabrication and assembly of supports.
2. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases, indicated to comply with performance requirements and design criteria, including analysis data[**signed and sealed by the qualified professional engineer responsible for their preparation**].

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates for air compressors, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Qualification Statements: For [**Installer**][**and**][**testing agency**].

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air equipment.

1. Indicate actual installed items by marking the submittals with an arrow or box.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[**, from the same production run,**] to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Air Compressor, Inlet-Air Filter Elements: Equal to <**Insert number**> percent of quantity installed, but no fewer than <**Insert number**> units.
2. Belts: [**One**][**Two**]<**Insert number**> for each belt-driven compressor.

1.7 FIELD CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with the requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.10 QUALITY ASSURANCE

A. Installer Qualifications:

1. Laboratory Air Equipment for Laboratory Facilities: An employer of workers trained and approved by manufacturer.
2. Medical Air Equipment for Healthcare Facilities: Qualify installers in accordance with ASSE 6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the compressed-air equipment testing indicated, that is[**a member of the Medical Gas Professional Healthcare Organization or is**] an NRTL and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel in accordance with ASSE 6020 for inspectors and ASSE 6030 for verifiers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 99, "Health Care Facilities Code," for compressed-air equipment and accessories for medical and dental compressed-air systems.

C. ASME Compliance: Fabricate and label receivers to comply with 2021 ASME Boiler and Pressure Vessel Code.

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design compressed-air equipment mounting.

E. Seismic Performance: Compressed-air equipment to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.[**See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**]

1. The term "withstand" means the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 GENERAL REQUIREMENTS FOR COMPRESSED-AIR SYSTEMS

A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120 V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Automatic control switches to [**alternate lead-lag air compressors for duplex**][**and**][**sequence lead-lag air compressors for three or more**] air compressors.
7. Instrumentation: Include discharge-air and receiver pressure gauges, air-filter maintenance indicator, hour meter, air compressor discharge-air and coolant temperature gauges, and control transformer.
8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
9. Provide 65k AIC SCCR rating.

C. Receivers: Steel tank constructed in accordance with 2021 ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1. Pressure Rating: At least as high as highest discharge pressure of connected air compressors and bearing appropriate code symbols.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: Include safety valve, pressure gauge, automatic drain, pressure regulator, and piped three-valve bypass with valves.

D. Mounting Frame: Fabricate base and attachment to air compressor and components with reinforcement strong enough to resist movement during a seismic event when base is anchored to building structure.

2.3 MEDICAL COMPRESSED-AIR PACKAGED SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**EMSE Corporation**]
4. [**Ohio Medical Corporation**]
5. [**Powerex, Inc.**]
6. [**Tri-Tech Medical**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**EMSE Corporation**]
4. [**Ohio Medical Corporation**]
5. [**Powerex, Inc.**]
6. [**Tri-Tech Medical**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain medical compressed-air packaged system from single source from single manufacturer.

D. Description: Medical compressed-air packaged system, factory assembled on a common base, factory tested, fully compliant with NFPA 99 and featuring single-point connections for electrical power, intake air, discharge air, and condensate drains. Components are to include compressor(s), receiver, dryer(s), filter/pressure regulator system, all interconnecting piping, power, and control wiring, and UL-labeled control system.

E. Capacities and Characteristics:

1. Compressed-Air Service: Medical compressed air.
2. Air Compressor(s): Oil-less [**duplex**]<**Insert number**>, [**scroll**][**or**][**reciprocating**]<**Insert type**>.
3. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
5. Discharge-Air Pressure: [**80 psig (550 kPa)**][**125 psig (860 kPa)**][**175 psig (1200 kPa)**]<**Insert value**>.
6. Intake-Air Temperature: <**Insert deg F (deg C)**>.
7. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
8. Mounting: [**Freestanding**][**Tank mounted**].
9. Motor (Each Air Compressor):

a. Horsepower: <**Insert value**>.
b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

10. Electrical Characteristics:

a. Volts: <**Insert value**>.
b. Phase(s): [**Single**][**Three**].
c. Hertz: [**60**]<**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

11. Receiver:

a. Orientation: [**Horizontal**][**Vertical**] arrangement.
b. Capacity: <**Insert gal. (L)**>.
c. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
d. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> minimum.
e. Pressure Regulator Setting: <**Insert psig (kPa)**>.
f. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
g. Drain: [**Automatic**][**Manual**] valve.

12. Compressed-Air Dryer: [**Desiccant**][**Refrigerated**].

a. Description:

1) Twin-tower unit with purge system, mufflers, and capability to deliver [**plus 10 deg F (minus 12 deg C)**]<**Insert temperature**>, **100 psig (690 kPa)** air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.
2) Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver **35 deg F (2 deg C)**, **100 psig (690 kPa)** air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

b. Capacities and Characteristics:

1) Standard-Air Capacity of Each Compressed-Air Dryer: <**Insert scfm (standard L/s)**> free air.
2) Pressure: <**Insert psig (kPa)**>.
3) Entering-Air Temperature: <**Insert deg F (deg C)**>.
4) Leaving-Air Temperature: <**Insert deg F (deg C)**>.
5) Leaving-Air Pressure Dew Point: <**Insert deg F (deg C)**>.
6) Ambient-Air Temperature: <**Insert deg F (deg C)**>.
7) Maximum Air-Pressure Drop: <**Insert psig (kPa)**>.
8) Inlet Filter: [**5**]<**Insert number**> micrometers.
9) Outlet Filter: [**1**]<**Insert number**> micrometer(s).
10) Motor Horsepower: <**Insert value**>.
11) Electrical Characteristics:

a) Volts: <**Insert value**>.
b) Phase(s): [**Single**][**Three**].
c) Hertz: [**60**]<**Insert value**>.

d) Full-Load Amperes: <**Insert value**>.
e) Minimum Circuit Ampacity: <**Insert value**>.
f) Maximum Overcurrent Protection: <**Insert amperage**>.

13. Compressed-air filter and purification system.
14. Control System:

a. Description: Duplex mounted and wired control system.

1) UL labeled.
2) NEMA ICS 6, Type 12 control panel enclosure.
3) Circuit-breaker disconnects for each motor with external operators.
4) Full voltage motor starters with overload protection.
5) 24 V control circuit.
6) 65k AIC SCCR rating.
7) Touchscreen controls.
8) Screen displays and functions (to include, but not limited to, the following):

a) Service alerts.
b) Runtime hours.
c) System status.
d) System pressure level.
e) Dew point level.
f) CO level.
g) Event logs.
h) <**Insert type**>.

9) Ethernet connectivity with embedded web page for remote monitoring.
10) Integral connectivity to the medical gas network via Ethernet.
11) Optional connectivity - BACnet communication with TCP/IP protocol.

2.4 INSTRUMENT COMPRESSED-AIR PACKAGED SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**EMSE Corporation**]
4. [**Ohio Medical Corporation**]
5. [**Powerex, Inc.**]
6. [**Tri-Tech Medical**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**EMSE Corporation**]
4. [**Ohio Medical Corporation**]
5. [**Powerex, Inc.**]
6. [**Tri-Tech Medical**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain instrument compressed-air packaged system from single source from single manufacturer.

D. Description: Instrument compressed-air packaged system, factory assembled on a common base, factory tested, fully compliant with NFPA 99 and featuring single-point connections for electrical power, intake air, discharge air, and condensate drains. Components are to include compressor(s), receiver, dryer(s), filter/pressure regulator system, all interconnecting piping, power, and control wiring, and UL-labeled control system.

E. Capacities and Characteristics:

1. Compressed-Air Service: Instrument compressed air.
2. Air Compressor(s): [**Duplex**]<**Insert number**>, [**reciprocating**]<**Insert type**>.
3. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
5. Discharge-Air Pressure: [**125 psig (860 kPa)**][**175 psig (1200 kPa)**]<**Insert value**>.
6. Intake-Air Temperature: <**Insert deg F (deg C)**>.
7. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
8. Mounting: [**Freestanding**][**Tank mounted**].
9. Motor (Each Air Compressor):
    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.
10. Electrical Characteristics:
    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.
11. Receiver:
    a. Orientation: [**Horizontal**][**Vertical**] arrangement.
    b. Capacity: <**Insert gal. (L)**>.
    c. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
    d. Pressure Rating: [**250 psig (1725 kPa)**]<**Insert value**> minimum.
    e. Pressure Regulator Setting: <**Insert psig (kPa)**>.
    f. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
    g. Drain: [**Automatic**][**Manual**] valve.
12. Compressed-Air Dryer: [**Desiccant**]<**Insert type**>.
    a. Description: Twin-tower unit with purge system, mufflers, and capability to deliver [**plus 10 deg F (minus 12 deg C)**]<**Insert temperature**>, **100 psig (690 kPa)** air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.
    b. Capacities and Characteristics:
        1) Standard-Air Capacity of Each Compressed-Air Dryer: <**Insert scfm (standard L/s)**> free air.
        2) Pressure: <**Insert psig (kPa)**>.
        3) Entering-Air Temperature: <**Insert deg F (deg C)**>.

4) Leaving-Air Temperature: <**Insert deg F (deg C)**>.
5) Leaving-Air Pressure Dew Point: <**Insert deg F (deg C)**>.
6) Ambient-Air Temperature: <**Insert deg F (deg C)**>.
7) Maximum Air-Pressure Drop: <**Insert psig (kPa)**>.
8) Inlet Filter: [**5**]<**Insert number**> micrometers.
9) Outlet Filter: [**1**]<**Insert number**> micrometer(s).
10) Motor Horsepower: <**Insert value**>.
11) Electrical Characteristics:

a) Volts: <**Insert value**>.
b) Phase(s): [**Single**][**Three**].
c) Hertz: [**60**]<**Insert value**>.
d) Full-Load Amperes: <**Insert value**>.
e) Minimum Circuit Ampacity: <**Insert value**>.
f) Maximum Overcurrent Protection: <**Insert amperage**>.

13. Compressed-air filter and purification system.
14. Control System:

a. Description: Duplex mounted and wired control system.

1) UL labeled.
2) NEMA ICS 6, Type 12 control panel enclosure.
3) Circuit-breaker disconnects for each motor with external operators.
4) Full voltage motor starters with overload protection.
5) 24 V control circuit.
6) 65k AIC SCCR rating.
7) Touchscreen controls.
8) Screen displays and functions (to include, but not limited to, the following):

a) Service alerts.
b) Runtime hours.
c) System status.
d) System pressure level.
e) Dew point level.
f) CO level.
g) Event logs.
h) <**Insert type**>.

9) Ethernet connectivity with embedded web page for remote monitoring.
10) Integral connectivity to the medical gas network via Ethernet.
11) Optional connectivity - BACnet communication with TCP/IP protocol.

2.5 AIR COMPRESSOR PACKAGED SYSTEM - RECIPROCATING, OIL LESS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**Atlas Copco**]
3. [**EMSE Corporation**]
4. [**FS-Curtis**]
5. [**Ohio Medical Corporation**]
6. [**Powerex, Inc.**]

7. [**Tri-Tech Medical**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**Atlas Copco**]
3. [**EMSE Corporation**]
4. [**FS-Curtis**]
5. [**Ohio Medical Corporation**]
6. [**Powerex, Inc.**]
7. [**Tri-Tech Medical**]
8. <**Insert manufacturer's name**>

C. Source Limitations: Obtain reciprocating, oil-less, air compressors from single source from single manufacturer.

D. Description: Packaged system.

E. Compressor(s): [**Single**][**or**][**two**]-stage, oil-less (nonlubricated), reciprocating-piston type, with sealed oil-free bearings, that will deliver air of quality equal to intake air.

1. High discharge-air temperature switch.
2. Belt guard totally enclosing pulleys and belts.
3. Intercooler between stages of two-stage units.

F. Receiver and accessories.

G. Capacities and Characteristics:

1. Compressed-Air Service: [**Dental**][**Laboratory**]<**Insert service**> air.
2. Air Compressor(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
5. Discharge-Air Pressure: [**80 psig (550 kPa)**][**125 psig (860 kPa)**][**175 psig (1200 kPa)**]<**Insert value**>.
6. Intake-Air Temperature: <**Insert deg F (deg C)**>.
7. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
8. Mounting: [**Freestanding**][**Tank mounted**].
9. Motor (Each Air Compressor):

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

10. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

11. Receiver:

a. Orientation: [**Horizontal**][**Vertical**] arrangement.
b. Capacity: <**Insert gal. (L)**>.
c. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
d. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> minimum.
e. Pressure Regulator Setting: <**Insert psig (kPa)**>.
f. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
g. Drain: [**Automatic**][**Manual**] valve.

2.6 AIR COMPRESSOR PACKAGED SYSTEM - LIQUID RING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Flowserve SIHI**]
2. [**Nash; an Ingersoll Rand Business**]
3. [**Travaini Pumps USA, Inc**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Flowserve SIHI**]
2. [**Nash; an Ingersoll Rand Business**]
3. [**Travaini Pumps USA, Inc**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain liquid-ring air compressors from single source from single manufacturer.

D. Description: Packaged system.

E. Compressor(s): Nonpulsating, rotary, liquid-ring type.

1. Construction: [**Cast-iron body with bronze rotor**][**Bronze body and rotor**][**Cast-iron or bronze body and bronze rotor**].
2. Coupling: Nonlubricated, flexible type.
3. Sealing Fluid: Potable water.

F. Capacities and Characteristics:

1. Compressed-Air Service: [**Laboratory**]<**Insert service**> air.
2. Compressor(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
5. Discharge-Air Pressure: [**80 psig (550 kPa)**][**100 psig (690 kPa)**]<**Insert value**>.
6. Intake-Air Temperature: <**Insert deg F (deg C)**>.
7. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
8. Mounting: [**Freestanding**][**Tank mounted**].
9. Motor (Each Air Compressor):

a. Horsepower: <**Insert value**>.
b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

10. Electrical Characteristics:

a. Volts: <**Insert value**>.
b. Phase(s): [**Single**][**Three**].
c. Hertz: [**60**]<**Insert value**>.
d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

11. Receiver: ASME construction steel tank.

a. Orientation: [**Horizontal**][**Vertical**] arrangement.
b. Capacity: <**Insert gal. (L)**>.
c. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
d. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert value**> minimum.
e. Pressure Regulator Setting: <**Insert psig (kPa)**>.
f. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
g. Drain: [**Automatic**][**Manual**] valve.

2.7 AIR COMPRESSOR PACKAGED SYSTEM - ROTARY SCREW

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Atlas Copco**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Atlas Copco**]
2. <**Insert manufacturer's name**>

C. Source Limitations: Obtain rotary-screw air compressors from single source from single manufacturer.

D. Description: Packaged system.

E. Air Compressor(s): Single-stage, oil-free, rotary-screw type with nonlubricated helical screws and lubricated gearbox, and of construction that prohibits oil from entering compression chamber.

1. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air-pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal-bypass valve.
2. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
3. Air/Coolant Receiver and Separation System: **150 psig (1035 kPa)** rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal-bypass valve.
4. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between **50 and 100 psig (345 and 690 kPa)**. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

a. Mounting: Freestanding.

F. Sound-attenuation enclosure.

G. Capacities and Characteristics:

1. Compressed-Air Service: [**Dental**][**Laboratory**]<**Insert service**> air.
2. Air Compressor(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
5. Discharge-Air Pressure: [**80 psig (550 kPa)**][**110 psig (760 kPa)**]<**Insert value**>.
6. Intake-Air Temperature: <**Insert deg F (deg C)**>.
7. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
8. Motor (Each Air Compressor):
    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.
9. Electrical Characteristics:
    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.
10. Receiver: ASME construction steel tank.
    a. Orientation: [**Horizontal**][**Vertical**] arrangement.
    b. Capacity: <**Insert gal. (L)**>.
    c. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
    d. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert value**> minimum.
    e. Pressure Regulator Setting: <**Insert psig (kPa)**>.
    f. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
    g. Drain: [**Automatic**][**Manual**] valve.

2.8 AIR COMPRESSOR PACKAGED SYSTEM - SCROLL

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Ohio Medical Corporation**]
4. [**Powerex, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]
2. [**BeaconMedaes**]
3. [**Ohio Medical Corporation**]
4. [**Powerex, Inc.**]

5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain scroll air compressors from single source from single manufacturer.

D. Description: Packaged system.

E. Air Compressor(s): Single-stage, oil-free, rotary, oscillating-volute type of construction that prohibits oil from entering compression chamber.

1. Mounting: Freestanding.

F. Capacities and Characteristics:

1. Compressed-Air Service: [**Dental**][**Laboratory**]<**Insert service**> air.
2. Air Compressor(s): [**Simplex**][**Duplex**]<**Insert number**>.
3. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
4. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
5. Discharge-Air Pressure: [**80 psig (550 kPa)**][**110 psig (760 kPa)**]<**Insert value**>.
6. Intake-Air Temperature: <**Insert deg F (deg C)**>.
7. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
8. Motor (Each Air Compressor):

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

9. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

10. Receiver: ASME construction steel tank.

    a. Orientation: [**Horizontal**][**Vertical**] arrangement.
    b. Capacity: <**Insert gal. (L)**>.
    c. Interior Finish: [**Epoxy**][**Epoxy or galvanized**][**Galvanized**]<**Insert coating**>.
    d. Pressure Rating: [**100 psig (690 kPa)**][**125 psig (860 kPa)**][**150 psig (1035 kPa)**]<**Insert value**> minimum.
    e. Pressure Regulator Setting: <**Insert psig (kPa)**>.
    f. Pressure Relief Valve Setting: <**Insert psig (kPa)**>.
    g. Drain: [**Automatic**][**Manual**] valve.

2.9 AIR COMPRESSOR PACKAGED SYSTEM - DIAPHRAGM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ACI Medical, Inc**]
2. [**Air Dimensions, Inc.**]
3. [**Gast Manufacturing Inc**]

4. [**KNF Neuberger, Inc**]
5. [**Thomas; an Ingersoll Rand Business**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ACI Medical, Inc**]
2. [**Air Dimensions, Inc.**]
3. [**Gast Manufacturing Inc**]
4. [**KNF Neuberger, Inc**]
5. [**Thomas; an Ingersoll Rand Business**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain diaphragm air compressors from single source from single manufacturer.

D. Description: Simplex, single-stage, oil-free diaphragm air compressor with nonlubricated compression chamber and lubricated or dry crankcase, and of construction that prohibits oil from entering compression chamber.

1. Option: Construction may be articulating-piston, reciprocating-piston, or rotary-sliding-vane type.

E. Control: Adjustable pressure switch.

F. Mounting: Freestanding.

G. Capacities and Characteristics:

1. Compressed-Air Service: [**Laboratory**]<**Insert service**> air.
2. Standard-Air Capacity of Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**10 psig (69 kPa)**][**15 psig (103 kPa)**]<**Insert value**>.
5. Intake-Air Temperature: <**Insert deg F (deg C)**>.
6. Discharge-Air Temperature: <**Insert deg F (deg C)**>.
7. Motor (Each Air Compressor):

    a. Horsepower: <**Insert value**>.
    b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.

8. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.10 AIR FILTERS - INLET TYPE

A. Air Filters - Inlet Type:

1. Source Limitations: Obtain inlet-type air filters from single source from single manufacturer.
2. Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor:

a. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
b. Capacity: Match capacity of air compressor, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

3. Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors:

a. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
b. Capacity: Match total capacity of connected air compressors, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.11 COMPRESSED-AIR DRYERS - REFRIGERATED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air/Tak, Inc**]
2. [**Atlas Copco**]
3. [**EMSE Corporation**]
4. [**FS-Curtis**]
5. [**Gardner Denver, an Ingersoll Rand business**]
6. [**Ingersoll Rand**]
7. [**Kaeser Compressors, Inc**]
8. [**Parker (Parker Hannifin)**]
9. [**Pioneer Air Systems, Inc**]
10. [**SPXFLOW, Air Treatment**]
11. [**Wilkerson Operations**]
12. [**Zeks Compressed Air Solutions**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air/Tak, Inc**]
2. [**Atlas Copco**]
3. [**EMSE Corporation**]
4. [**FS-Curtis**]
5. [**Gardner Denver, an Ingersoll Rand business**]
6. [**Ingersoll Rand**]
7. [**Kaeser Compressors, Inc**]
8. [**Parker (Parker Hannifin)**]
9. [**Pioneer Air Systems, Inc**]
10. [**SPXFLOW, Air Treatment**]
11. [**Wilkerson Operations**]
12. [**Zeks Compressed Air Solutions**]
13. <**Insert manufacturer's name**>

C. Source Limitations: Obtain refrigerated compressed-air dryers from single source from single manufacturer.

D. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver **35 deg F (2 deg C)**, **100 psig (690 kPa)** air at dew point. Include automatic ejection of

condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

E. Capacities and Characteristics:

1. Standard-Air Capacity of Each Compressed-Air Dryer: <**Insert scfm (standard L/s)**> free air.
2. Pressure: <**Insert psig (kPa)**>.
3. Entering-Air Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Pressure Dew Point: <**Insert deg F (deg C)**>.
6. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
7. Maximum Air-Pressure Drop: <**Insert psig (kPa)**>.
8. Inlet Filter: [**5**]<**Insert number**> micrometers.
9. Outlet Filter: [**1**]<**Insert number**> micrometer(s).
10. Motor Horsepower: <**Insert value**>.
11. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.12 COMPRESSED-AIR DRYERS - DESICCANT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air/Tak, Inc**]
2. [**BeaconMedaes**]
3. [**EMSE Corporation**]
4. [**FS-Curtis**]
5. [**Gardner Denver, an Ingersoll Rand business**]
6. [**Ingersoll Rand**]
7. [**Kaeser Compressors, Inc**]
8. [**Parker (Parker Hannifin)**]
9. [**Pioneer Air Systems, Inc**]
10. [**SPXFLOW, Air Treatment**]
11. [**Van Air Systems, Inc**]
12. [**Wilkerson Operations**]
13. [**Zeks Compressed Air Solutions**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air/Tak, Inc**]
2. [**BeaconMedaes**]
3. [**EMSE Corporation**]
4. [**FS-Curtis**]
5. [**Gardner Denver, an Ingersoll Rand business**]
6. [**Ingersoll Rand**]
7. [**Kaeser Compressors, Inc**]

8. [**Parker (Parker Hannifin)**]
9. [**Pioneer Air Systems, Inc**]
10. [**SPXFLOW, Air Treatment**]
11. [**Van Air Systems, Inc**]
12. [**Wilkerson Operations**]
13. [**Zeks Compressed Air Solutions**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain desiccant compressed-air dryers from single source from single manufacturer.

D. Description: Twin-tower unit with purge system, mufflers, and capability to deliver [**plus 10 deg F (minus 12 deg C)**]<**Insert temperature**>, **100 psig (690 kPa)** air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

E. Capacities and Characteristics:

1. Standard-Air Capacity of Each Compressed-Air Dryer: <**Insert scfm (standard L/s)**> free air.
2. Pressure: <**Insert psig (kPa)**>.
3. Entering-Air Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Pressure Dew Point: <**Insert deg F (deg C)**>.
6. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
7. Maximum Air-Pressure Drop: <**Insert psig (kPa)**>.
8. Inlet Filter: [**5**]<**Insert number**> micrometers.
9. Outlet Filter: [**1**]<**Insert number**> micrometer(s).
10. Motor Horsepower: <**Insert value**>.
11. Electrical Characteristics:

    a. Volts: <**Insert value**>.
    b. Phase(s): [**Single**][**Three**].
    c. Hertz: [**60**]<**Insert value**>.
    d. Full-Load Amperes: <**Insert value**>.
    e. Minimum Circuit Ampacity: <**Insert value**>.
    f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.13 COMPRESSED-AIR PURIFICATION SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Healthcare Products Inc.**]
2. [**Donaldson Company, Inc.**]
3. [**Parker (Parker Hannifin)**]
4. [**Pioneer Air Systems, Inc**]
5. [**SPXFLOW, Air Treatment**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Healthcare Products Inc.**]

2. [**Donaldson Company, Inc.**]
3. [**Parker (Parker Hannifin)**]
4. [**Pioneer Air Systems, Inc**]
5. [**SPXFLOW, Air Treatment**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain compressed-air purification systems from single source from single manufacturer.

D. Description: Compressed-air purification system sized for maximum connected equipment capacity with coalescing, particulate, and activated-charcoal filters; compressed-air dryer; catalytic converter; gauges and thermometers; and controls.

E. Include the following capabilities:

1. Removal of excessive moisture, solid particulates, oil and oil mist, carbon monoxide, and hydrocarbon vapors.
2. Automatic ejection of condensate from airstream.
3. Production of air complying with USP - NF for medical air.
4. Capacity and dew point indicated, but not higher than [**35 deg F (2 deg C) at 100 psig (690 kPa)**]<**Insert temperature and value**>.

F. Filters: Parallel duplex filters, each sized for maximum system demand, with valved bypass for filter servicing.

1. Inlet Filters: [**5**]<**Insert number**> micrometers.
2. Outlet Filters: [**1**]<**Insert number**> micrometer(s).

G. Accessories: Inlet and outlet pressure gauges, thermometers, safety valves, and shutoff valves; and automatic ejection of condensate from airstream.

H. Differential Pressure Switch: Adjustable, diaphragm type, with electrical connections for alarm system, to indicate when air-pressure drop through filters rises to more than **2 psig (13.8 kPa)** greater than when new and clean.

1. Inlet Connection: From inlet to particulate filter.
2. Outlet Connection: To outlet from final activated-charcoal filter.

I. Compressed-Air Dryer: [**Twin-tower desiccant type with automatic controls, purge system, and mufflers**][**Noncycling refrigerant type**].

J. Capacities and Characteristics:

1. Standard-Air Capacity of Each Compressed-Air Purification System: <**Insert scfm (standard L/s)**> free air.
2. Entering-Air Pressure: <**Insert psig (kPa)**>.
3. Entering-Air Temperature: <**Insert deg F (deg C)**>.
4. Leaving-Air Temperature: <**Insert deg F (deg C)**>.
5. Leaving-Air Pressure Dew Point: <**Insert deg F (deg C)**>.
6. Ambient-Air Temperature: <**Insert deg F (deg C)**>.
7. Maximum Compressed-Air Pressure Drop: <**Insert psig (kPa)**>.
8. Electrical Characteristics:

a. Volts: <**Insert value**>.
b. Phase(s): [**Single**][**Three**].
c. Hertz: [**60**]<**Insert value**>.

d. Full-Load Amperes: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.14 COMPRESSED-AIR FILTER ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Arrow Pneumatics, Inc**]
2. [**Dollinger; Celeros Flow Technology**]
3. [**Donaldson Company, Inc.**]
4. [**EMSE Corporation**]
5. [**Ingersoll Rand**]
6. [**Parker (Parker Hannifin)**]
7. [**Pioneer Air Systems, Inc**]
8. [**SPXFLOW, Air Treatment**]
9. [**Van Air Systems, Inc**]
10. [**Zeks Compressed Air Solutions**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Arrow Pneumatics, Inc**]
2. [**Dollinger; Celeros Flow Technology**]
3. [**Donaldson Company, Inc.**]
4. [**EMSE Corporation**]
5. [**Ingersoll Rand**]
6. [**Parker (Parker Hannifin)**]
7. [**Pioneer Air Systems, Inc**]
8. [**SPXFLOW, Air Treatment**]
9. [**Van Air Systems, Inc**]
10. [**Zeks Compressed Air Solutions**]
11. <**Insert manufacturer's name**>

C. Source Limitations: Obtain compressed-air filter assemblies from single source from single manufacturer.

D. Description: Filter assemblies suitable for compressed air, in parallel duplex arrangement. Size each assembly for maximum capacity of connected equipment and operating pressure of compressed-air system. Include automatic ejection of condensate from airstream, inlet and outlet pressure gauges, and shutoff valves.

1. Option: Factory-fabricated filter system consisting of three air filters equivalent to those specified, pipe, fittings, valves, differential pressure switch, and enclosure; and with additional automatic drain traps and gauges.

E. Size filter assemblies for [**5 psig (34.5 kPa)**]<**Insert value**> maximum air-pressure drop when filters are new and clean, at system rated capacity, and at **100 psig (690 kPa)** pressure.

F. Differential Pressure Switch: Adjustable, diaphragm type, with electrical connections for alarm system, to indicate when air-pressure drop through filters rises to more than **2 psig (13.8 kPa)** greater than

when new and clean.

G. Particulate Filters: Collection efficiency of 98 percent retention of particles 1 micrometer and larger.

H. Odor and Taste Filters: Vapor-absorbing, activated charcoal.

I. Coalescing Filters: Collection efficiency of 99.9 percent retention of particles 0.3 micrometer and smaller.

J. Include automatic drain trap for each filter.

2.15 DENTAL COMPRESSED-AIR PACKAGED SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air Techniques**]
2. [**DentalEZ**]
3. [**Midmark Corp.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air Techniques**]
2. [**DentalEZ**]
3. [**Midmark Corp.**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain dental compressed-air systems from single source from single manufacturer.

D. Description: Factory-assembled, -tested, and -packaged; automatic, dental compressed-air system that will deliver air of quality at least equal to intake air; suitable for dental applications and capable of producing air at [**80 psig (550 kPa)**]<**Insert value**>.

E. Air Compressor(s): Oil-less reciprocating type.

1. Option: Construction may be oil-free, sliding-vane or scroll type.

F. Compressor Controls: Adjustable, tank-mounted, pressure [**switches and alternator for duplex air compressors**][**switch for simplex air compressor**].

G. Check Valves: In discharge piping of each air compressor.

H. Air Filter: Integral with air compressor or separate unit for field installation in compressed-air piping.

I. Dryer:

1. Desiccant type, integral with air compressor or separate unit for field installation in compressed-air piping.
2. Refrigerated [**35 deg F (2 deg C)**]<**Insert temperature**> dew point, in cabinet with automatic controls, for remote installation. Include on-off switch, on light, inlet and outlet temperature indicators, high-temperature alarm, and rubber isolators on feet.

J. Receiver: Steel tank rated for at least **100 psig (690 kPa)** with rubber isolators on feet.

1. Pressure Regulator: Adjustable.
2. Safety Valve: ASME relief valve with setting of **100 psig (690 kPa)** or less.
3. Drain: [**Automatic**][**Manual**] valve.

K. Cabinet: Enameled steel, with control panel with manual on-off switch, on light, and pressure gauge.[**Refrigeration-type dryer may be separate with integral cabinet.**]

L. Capacities and Characteristics:

1. Air Compressor(s): [**Simplex**][**Duplex**]<**Insert number**>.
2. Standard-Air Capacity of Each Air Compressor: <**Insert scfm (standard L/s)**> free air.
3. Actual-Air Capacity of Each Air Compressor: <**Insert acfm (actual L/s)**> delivered.
4. Discharge-Air Pressure: [**80 psig (550 kPa)**]<**Insert value**>.
5. Arrangement: [**Duplex, mounted on horizontal**][**Simplex, mounted on horizontal**][**Simplex, mounted on vertical**] receiver.
6. Motor (Each Air Compressor):
   a. Horsepower: <**Insert value**>.
   b. Speed: [**1750**][**3400**]<**Insert speed**> rpm.
7. Electrical Characteristics:
   a. Volts: <**Insert value**>.
   b. Phase(s): [**Single**][**Three**].
   c. Hertz: [**60**]<**Insert value**>.
   d. Full-Load Amperes: <**Insert value**>.
   e. Minimum Circuit Ampacity: <**Insert value**>.
   f. Maximum Overcurrent Protection: <**Insert amperage**>.

2.16 DENTAL COMPRESSED-AIR SYSTEM CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Air Techniques**]
2. [**DentalEZ**]
3. [**Midmark Corp.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Air Techniques**]
2. [**DentalEZ**]
3. [**Midmark Corp.**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain dental compressed-air system control panels from single source from single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a

qualified testing agency, and marked for intended location and application.

E. Description: Wall-mounted type with visual indicators to indicate equipment in operation and to perform the following:

1. Shut off dental air equipment.
2. Shut off water supply to dental air equipment. Include solenoid-operated valve for installation in water piping.

F. Control panels may be combined with dental vacuum pump control panels in single dental equipment control panels.

2.17 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Enclosure: [**Open, dripproof**][**Totally enclosed, fan cooled**][**Totally enclosed, air over**][**Open, externally ventilated**][**Totally enclosed, nonventilated**][**Severe duty**][**Explosion proof**][**Dust-ignition-proof machine**].
2. Enclosure Materials: [**Cast iron**][**Cast aluminum**][**Rolled steel**].
3. Motor Bearings: <**Insert requirements**>.
4. Unusual Service Conditions:

   a. Ambient Temperature: <**Insert deg C**>.
   b. Altitude: <**Insert feet (meter)**> above sea level.
   c. High humidity.
   d. <**Insert conditions**>.

5. Efficiency: Premium efficient.
6. NEMA Design: <**Insert designation**>.
7. Service Factor: <**Insert value**>.
8. Electrical Characteristics:

   a. Horsepower: <**Insert horsepower**>.
   b. Volts: [**115**][**200**][**230**][**460**]<**Insert value**>.
   c. Phase: [**Single**][**Poly**].
   d. Hertz: [**60**]<**Insert value**>.
   e. Full-Load Amperes: <**Insert value**>.
   f. Minimum Circuit Ampacity: <**Insert value**>.
   g. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Compressed-air equipment, accessories, and components are to be factory cleaned for oxygen service and sealed and furnished suitable for [**laboratory air**][**and**][**medical/instrument air**] applications, in accordance with CGA G-4.1, "Cleaning of Equipment for Oxygen Service."

B. Compressed-air equipment, accessories, and components that have not been cleaned for oxygen service, or have been cleaned but become contaminated and unsuitable for [**laboratory air**][**and**][**medical/instrument air**] applications, are not to be used.

3.2 INSTALLATION OF COMPRESSED-AIR EQUIPMENT

A. General Requirements for Compressed-Air Equipment Installation:

1. Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.
2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.
3. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
4. Install equipment to allow right of way for piping installed at required slope.
5. Install the following devices on compressed-air equipment:

    a. Thermometer, Pressure Gauge, and Safety Valve: Install on each compressed-air receiver.
    b. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.
    c. Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

B. Laboratory Compressed-Air Equipment Installation:

1. Install compressed-air equipment, except wall-mounted equipment[**and diaphragm air compressors**], on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
4. Install diaphragm air compressors on [**floor**][**counter**]<**Insert location**>.

    a. Anchor air compressors to surface in accordance with manufacturer's written instructions[**and seismic criteria applicable to Project**].

C. Medical Compressed-Air Equipment Installation:

1. Install in accordance with ASSE 6010 and NFPA 99.
2. Install compressed-air equipment, except wall-mounted equipment, on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
3. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
4. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

D. Dental Air System Equipment Installation:

1. Install in accordance with ASSE 6010 and NFPA 99.
2. Install dental air system units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
3. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
4. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

5. Maintain manufacturer's recommended clearances for service and maintenance.
6. Install control panels for dental compressed-air equipment on wall near [**equipment**][**office entrance**]<**Insert location**>.

3.3 PIPING CONNECTIONS

A. Comply with requirements for water-supply piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for drain piping specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Comply with requirements for compressed-air piping specified in Section 226113 "Compressed-Air Piping for Laboratory and Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to equipment, allow space for service and maintenance.

E. Connect compressed-air piping to compressed-air equipment, accessories, and specialties with shutoff valve and union or flanged connection.

F. Connect water supply to compressed-air equipment that requires water. Include backflow preventer. Backflow preventers are specified in Section 221119 "Domestic Water Piping Specialties."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch (13 mm)** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Identify laboratory compressed-air equipment system components. Comply with requirements for

identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Identify medical compressed-air equipment system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" and with NFPA 99.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air compressor discharge pressure, but not higher than rating of system components.
7. Check for proper seismic restraints.
8. Drain receiver tank(s).
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.

B. Prepare written report documenting testing procedures and results.

3.8 ADJUSTING

A. Adjust equipment to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.9 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL COMPRESSED-AIR EQUIPMENT

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Medical Compressed-Air Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air equipment concurrently with tests, inspections, and certification of [**medical vacuum equipment**][**medical vacuum piping**][**medical compressed-air piping**][**and**][**medical gas piping**] systems.
2. Preparation: Perform medical compressed-air equipment tests in accordance with requirements in NFPA 99 for the following:

    a. Air-quality purity test.
    b. System operation test.

3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for

verification of medical compressed-air equipment.

4. Replace damaged and malfunctioning controls and equipment.
5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

    a. Inspections performed.
    b. Procedures, materials, and gases used.
    c. Test methods used.
    d. Results of tests.

6. Components will be considered defective if they do not pass tests and inspections and is to be replaced with new components.

C. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain air compressors[**, compressed-air dryers**][**compressed-air purification units**][**and**][**compressed-air filter assemblies**].

END OF SECTION 07 63 00 00A

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SECTION 07 63 00 00B - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Packed expansion joints.
3. Packless expansion joints.
4. Grooved-joint expansion joints.
5. Alignment guides and anchors.
6. Sleeves without waterstop.
7. Sleeves with waterstop.
8. Stack-sleeve fittings.
9. Sleeve-seal systems.
10. Grout.
11. Silicone sealants.
12. Escutcheons.
13. Thermometers, bimetallic actuated.
14. Thermometers, filled system.
15. Thermometers, liquid in glass.
16. Thermometers, light activated.
17. Duct-thermometer mounting brackets.
18. Thermowells.
19. Pressure gauges, dial type.
20. Gauge attachments.
21. Test plugs.
22. Test-plug kits.
23. Sight flow indicators.
24. Flowmeters.
25. Thermal-energy meters.

B. Related Requirements:

1. Section 231123 "Facility Natural-Gas Piping" for gas meters.
2. Section 232216 "Steam and Condensate Piping Specialties" for steam and condensate meters.
3. Section 230923.13 "Energy Meters" for thermal-energy meters connecting with the DDC system.
4. Section 230923.14 "Flow Instruments" for primary flow instruments connecting with the DDC system.

1.2 DEFINITIONS

A. Existing Piping To Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.

    a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
    b. Include operating characteristics and furnished accessories.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter.

B. Welding certificates.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of [**expansion joint,**][**meter,**][**and**][**gauge**] to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.7 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft. (1000 m)** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**]<**Insert class**>.
10. Code Letter Designation:
    a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.
11. Enclosure Material: Cast iron for motor frame sizes [**324T**]<**Insert number**> and larger; rolled steel for motor frame sizes smaller than [**324T**]<**Insert number**>.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [**120 V**][**or**][**240 V**] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [**Circuit board**][**or**][**digital speed controller/LED display**].
4. Building Automation System Interface: Via [**AC voltage signal**][**DC voltage signal**][**or**][**Digital Serial Interface (DSI)**].

2.2 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Packed Expansion Joints:

1. Flexible, Ball-Joint Packed Expansion Joints: [**FBJ-01**]<**Insert drawing designation**>.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**Advanced Thermal Systems, Inc**]
2) [**Hyspan Precision Products, Inc**]
3) [**Mason Industries, Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Thermal Systems, Inc**]
2) [**Hyspan Precision Products, Inc**]
3) [**Mason Industries, Inc.**]
4) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
d. Standards: 2021 ASME Boiler and Pressure Vessel Code: Section II, "Materials"; ASME B31.9 for materials and design of pressure-containing parts and bolting.
e. Material: Carbon-steel assembly with asbestos-free composition packing.
f. Design: Provide 360-degree rotation and angular deflection.
g. Minimum Pressure Rating: [**250 psig at 400 deg F (1725 kPa at 204 deg C)**]<**Insert value**>.
h. Angular Deflection for NPS 6 (DN 150) and Smaller: 30 degrees minimum.
i. Angular Deflection for NPS 8 (DN 200) and Larger: 15 degrees minimum.
j. Seal Type: Two carbon-steel and graphite seals suitable for continuous operation at temperature up to **650 deg F (343 deg C)**.
k. Internal Ball: Plated with minimum 1-mil chrome cover.
l. Ball Socket: One- or two-piece design with integral socket/retainer.

1) Stuffing Box: Incorporates containment seals and compression seals for containment of injectable packing.
2) Packing Cylinders: Provides packing under full line pressure with check valves to prevent blowback.

m. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
n. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2. Slip-Joint Packed Expansion Joints: [**SJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Advanced Thermal Systems, Inc**]
3) [**Hyspan Precision Products, Inc**]
4) [**Metraflex Company (The)**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of

the following:

1) [**Adsco Manufacturing LLC**]
2) [**Advanced Thermal Systems, Inc**]
3) [**Hyspan Precision Products, Inc**]
4) [**Metraflex Company (The)**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Obtain slip-joint packed expansion joints from single manufacturer.
d. Standard: ASTM F1007.
e. Material: Carbon steel with asbestos-free PTFE packing.
f. Design: With internal guide and injection ports for repacking under full system pressure. Housing is to be furnished with drain ports and lifting ring. Include drip connection if used for steam piping.
g. Configuration: [**Single joint**][**single joint with base**][**and**][**double joint with base**] class(es) unless otherwise indicated.
h. Slip Tube for Sizes NPS 1-1/2 (DN 40) through NPS 16 (DN 400): Schedule 80.
i. Slip Tube for Sizes NPS 18 (DN 450) through NPS 24 (DN 600): Schedule 60.
j. Sliding Surface: 2-mil-thick chrome finish.
k. End Connections: Flanged or welded ends to match piping system.

C. Packless Expansion Joints:

1. Metal, Compensator Packless Expansion Joints: [**MCEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Flex-Hose Co., Inc**]
2) [**Flex-Weld Inc., div of Kelco Industries**]
3) [**Flex-Weld; a division of Kelco**]
4) [**Flexicraft Industries**]
5) [**Hyspan Precision Products, Inc**]
6) [**Metraflex Company (The)**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Flex-Hose Co., Inc**]
2) [**Flex-Weld Inc., div of Kelco Industries**]
3) [**Flex-Weld; a division of Kelco**]
4) [**Flexicraft Industries**]
5) [**Hyspan Precision Products, Inc**]
6) [**Metraflex Company (The)**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Obtain metal compensator packless expansion joints from single manufacturer.
d. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**200 psig (1380 kPa)**]<**Insert value**> unless otherwise indicated.
e. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid

flow by an internal pipe sleeve and external housing.

f. Joint Axial Movement: **2 inches (50 mm)** of compression and **1/2 inch (12 mm)** of extension.

g. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.

1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: [**Solder joint**][**or**][**threaded**].
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.

h. Configuration for Steel Piping: Multi-ply, stainless steel bellows; steel-pipe end connections; and carbon-steel shroud.

1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Flanged**][**Threaded**][**Welded**].

2. Rubber Union Connector Expansion Joints: [**RUEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flo Fab Inc**]
4) [**General Rubber Corporation**]
5) [**Kadant Unaflex, LLC**]
6) [**Metraflex Company (The)**]
7) [**Proco Products, Inc**]
8) [**Unisource Manufacturing, Inc.**]
9) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flo Fab Inc**]
4) [**General Rubber Corporation**]
5) [**Kadant Unaflex, LLC**]
6) [**Metraflex Company (The)**]
7) [**Proco Products, Inc**]
8) [**Unisource Manufacturing, Inc.**]
9) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.

d. Material: Twin reinforced-rubber spheres[**with external restraining cables**].

e. Minimum Pressure Rating: [**150 psig at 170 deg F (1035 kPa at 77 deg C)**]<**Insert value**> unless otherwise indicated.

f. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

g. End Connections for Greater than NPS 2 (DN 50): Flanged.

3. Flexible-Hose Packless Expansion Joints: [**FHEJ-01**]<**Insert drawing designation**>.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**ASC Engineered Solutions**]
      2) [**Flex-Hose Co., Inc**]
      3) [**Flex-Pression**]
      4) [**Flex-Weld Inc., div of Kelco Industries**]
      5) [**Flex-Weld; a division of Kelco**]
      6) [**Flexicraft Industries**]
      7) [**Kadant Unaflex, LLC**]
      8) [**Metraflex Company (The)**]
      9) [**Proco Products, Inc**]
      10) [**Unisource Manufacturing, Inc.**]
      11) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**ASC Engineered Solutions**]
      2) [**Flex-Hose Co., Inc**]
      3) [**Flex-Pression**]
      4) [**Flex-Weld Inc., div of Kelco Industries**]
      5) [**Flex-Weld; a division of Kelco**]
      6) [**Flexicraft Industries**]
      7) [**Kadant Unaflex, LLC**]
      8) [**Metraflex Company (The)**]
      9) [**Proco Products, Inc**]
      10) [**Unisource Manufacturing, Inc.**]
      11) <**Insert manufacturer's name**>

   c. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.

   d. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

   e. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

   f. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with [**solder-joint**]<**Insert type**> end connections.

      1) Bronze hoses and single-braid bronze sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **340 psig at 450 deg F (2340 kPa at 232 deg C)** ratings.
      2) Bronze hoses and double-braid bronze sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **500 psig at 450 deg F (3450 kPa at 232 deg C)** ratings.

   g. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with [**threaded**]<**Insert type**> end connections.

      1) Stainless steel hoses and single-braid, stainless steel sheaths with

300 psig at 70 deg F (2070 kPa at 21 deg C) and **225 psig at 450 deg F (1550 kPa at 232 deg C)** ratings.

2) Stainless steel hoses and double-braid, stainless steel sheaths with **420 psig at 70 deg F (2890 kPa at 21 deg C)** and **315 psig at 450 deg F (2170 kPa at 232 deg C)** ratings.

h. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **450 psig at 70 deg F (3100 kPa at 21 deg C)** and **325 psig at 600 deg F (2250 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **700 psig at 70 deg F (4830 kPa at 21 deg C)** and **515 psig at 600 deg F (3550 kPa at 315 deg C)** ratings.

i. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon-steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **200 psig at 70 deg F (1380 kPa at 21 deg C)** and **145 psig at 600 deg F (1000 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **275 psig at 70 deg F (1900 kPa at 21 deg C)** and **200 psig at 600 deg F (1380 kPa at 315 deg C)** ratings.

j. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Carbon steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with **125 psig at 70 deg F (860 kPa at 21 deg C)** and **90 psig at 600 deg F (625 kPa at 315 deg C)** ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with **165 psig at 70 deg F (1130 kPa at 21 deg C)** and **120 psig at 600 deg F (830 kPa at 315 deg C)** ratings.

k. Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon-steel fittings with [**flanged**][**welded**] end connections.

1) Stainless steel hoses and double-braid, stainless steel sheaths with **165 psig at 70 deg F (1130 kPa at 21 deg C)** and **120 psig at 600 deg F (830 kPa at 315 deg C)** ratings.

4. Metal-Bellows Packless Expansion Joints: [**MBEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Badger Industries, Inc**]
3) [**Flex-Hose Co., Inc**]
4) [**Flex-Pression**]
5) [**Flex-Weld Inc., div of Kelco Industries**]
6) [**Flex-Weld; a division of Kelco**]

7) [**Flexicraft Industries**]
8) [**Flo Fab Inc**]
9) [**Hyspan Precision Products, Inc**]
10) [**Kadant Unaflex, LLC**]
11) [**Metraflex Company (The)**]
12) [**Proco Products, Inc**]
13) [**Senior Flexonics Pathway**]
14) [**Tozen Corporation**]
15) [**U.S. Bellows, Inc.**]
16) [**Unisource Manufacturing, Inc.**]
17) [**Universal Hose and Braid; a Hyspan Company**]
18) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Adsco Manufacturing LLC**]
2) [**Badger Industries, Inc**]
3) [**Flex-Hose Co., Inc**]
4) [**Flex-Pression**]
5) [**Flex-Weld Inc., div of Kelco Industries**]
6) [**Flex-Weld; a division of Kelco**]
7) [**Flexicraft Industries**]
8) [**Flo Fab Inc**]
9) [**Hyspan Precision Products, Inc**]
10) [**Kadant Unaflex, LLC**]
11) [**Metraflex Company (The)**]
12) [**Proco Products, Inc**]
13) [**Senior Flexonics Pathway**]
14) [**Tozen Corporation**]
15) [**U.S. Bellows, Inc.**]
16) [**Unisource Manufacturing, Inc.**]
17) [**Universal Hose and Braid; a Hyspan Company**]
18) <**Insert manufacturer's name**>

c. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
d. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
e. Type: Circular, corrugated bellows[**with external tie rods**].
f. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**175 psig (1200 kPa)**][**200 psig (1379 kPa)**]<**Insert value**> unless otherwise indicated.
g. Configuration: [**Single joint**][**Single joint with base**][**and**][**double joint with base**] class(es), unless otherwise indicated.
h. Expansion Joints for Copper Tubing: [**Single-**][**or**][**multi-**]ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: [**Solder joint**][**or**][**threaded**].
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Solder joint**][**or**][**threaded**].
3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.

i. Expansion Joints for Steel Piping: [**Single-**][**or**][**multi-**]ply stainless steel bellows, steel pipe

ends, and carbon steel shroud.

1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 (DN 65) and Larger: [**Flanged**][**Welded**].

5. Externally Pressurized Metal-Bellows Packless Expansion Joints: [**EPEJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Adsco Manufacturing LLC**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld Inc., div of Kelco Industries**]
5) [**Flex-Weld; a division of Kelco**]
6) [**Flexicraft Industries**]
7) [**Hyspan Precision Products, Inc**]
8) [**Metraflex Company (The)**]
9) [**Senior Flexonics Pathway**]
10) [**Tozen Corporation**]
11) [**U.S. Bellows, Inc.**]
12) [**Unisource Manufacturing, Inc.**]
13) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Adsco Manufacturing LLC**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Pression**]
4) [**Flex-Weld Inc., div of Kelco Industries**]
5) [**Flex-Weld; a division of Kelco**]
6) [**Flexicraft Industries**]
7) [**Hyspan Precision Products, Inc**]
8) [**Metraflex Company (The)**]
9) [**Senior Flexonics Pathway**]
10) [**Tozen Corporation**]
11) [**U.S. Bellows, Inc.**]
12) [**Unisource Manufacturing, Inc.**]
13) <**Insert manufacturer's name**>

c. Source Limitations: Obtain externally pressurized metal-bellows packless expansion joints from single manufacturer.
d. Minimum Pressure Rating: [**150 psig (1035 kPa)**][**200 psig (1379 kPa)**][**300 psig (2068 kPa)**]<**Insert value**> unless otherwise indicated.
e. Description:

1) Totally enclosed, externally pressurized, multi-ply, stainless steel bellows isolated from fluid flow by an internal pipe sleeve.
2) Carbon-steel housing.
3) Drain plugs and lifting lug for **NPS 3 (DN 80)** and larger.
4) Bellows: With operating clearance between internal pipe sleeves and external

shrouds.

5) Joints: Supplied with a built-in scale to confirm the starting position and operating movement.

6) Joint Axial Movement: [**4 inches (100 mm)**][**6 inches (150 mm)**][**8 inches (200 mm)**]<**Insert compression limit**> of compression and [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert extension limit**> of extension.

f. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are unacceptable.

g. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

6. Rubber Packless Expansion Joints: [**REJ-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Weld Inc., div of Kelco Industries**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Garlock Sealing Technologies**]
7) [**General Rubber Corporation**]
8) [**Kadant Unaflex, LLC**]
9) [**Metraflex Company (The)**]
10) [**Proco Products, Inc**]
11) [**Red Valve Company, Inc**]
12) [**Tozen Corporation**]
13) [**U.S. Bellows, Inc.**]
14) [**Unisource Manufacturing, Inc.**]
15) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Amber/Booth Company, Inc.; a VMC Group Company**]
2) [**Flex-Hose Co., Inc**]
3) [**Flex-Weld Inc., div of Kelco Industries**]
4) [**Flex-Weld; a division of Kelco**]
5) [**Flexicraft Industries**]
6) [**Garlock Sealing Technologies**]
7) [**General Rubber Corporation**]
8) [**Kadant Unaflex, LLC**]
9) [**Metraflex Company (The)**]
10) [**Proco Products, Inc**]
11) [**Red Valve Company, Inc**]
12) [**Tozen Corporation**]
13) [**U.S. Bellows, Inc.**]
14) [**Unisource Manufacturing, Inc.**]
15) <**Insert manufacturer's name**>

c. Source Limitations: Obtain rubber packless expansion joints from single manufacturer.
d. Standards: ASTM F1123 and FSA's "Expansion Joints - Piping Technical Handbook."
e. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
f. Arch Type: [**Single**][**or**][**multiple**] arches[**with external control rods**].
g. Spherical Type: [**Single**][**or**][**multiple**] spheres[**with external control rods**].
h. Minimum Pressure Rating for NPS 1-1/2 to NPS 12 (DN 40 to DN 300): [**225 psig (1551 kPa) at 170 deg F (77 deg C)**]<**Insert pressure and temperature values**>.
i. Material for Fluids Containing Acids, Alkalis, or Chemicals: [**Butyl rubber**][**Chlorosulfonyl-polyethylene rubber**][**EPDM rubber**]<**Insert material**>.
j. Material for Fluids Containing Gas, Hydrocarbons, or Oil: [**Buna-N**][**Chlorosulfonated polyethylene synthetic rubber**]<**Insert material**>.
k. Material for Water: [**Butyl rubber**][**Buna-N**][**Chlorosulfonated polyethylene synthetic rubber**][**Chlorosulfonyl-polyethylene rubber**][**EPDM rubber**][**Natural rubber**].
l. End Connections: Full-faced, integral steel flanges with steel retaining rings.

D. Grooved-Joint Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASC Engineered Solutions**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASC Engineered Solutions**]
b. [**Shurjoint; a part of Aalberts Integrated Piping Systems**]
c. [**Victaulic Company**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain grooved-joint expansion joints from single manufacturer.
4. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
5. Standard: AWWA C606, for grooved joints.
6. Materials: [**Galvanized,**]ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.
7. Couplings: [**Five**][**Seven**][**10**][**12**]<**Insert number**>, flexible type for steel-pipe dimensions. Include ferrous housing sections [**, Buna-N gasket,**][**, EPDM rubber gasket,**] and bolts and nuts.

E. Alignment Guides and Anchors:

1. Alignment Guides: [**AG-01**]<**Insert drawing designation**>.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Advanced Thermal Systems, Inc**]
2) [**Amber/Booth Company, Inc.; a VMC Group Company**]

3) [**ASC Engineered Solutions**]
4) [**Flex-Hose Co., Inc**]
5) [**Flex-Pression**]
6) [**Flex-Weld Inc., div of Kelco Industries**]
7) [**Flex-Weld; a division of Kelco**]
8) [**Flexicraft Industries**]
9) [**Hyspan Precision Products, Inc**]
10) [**Metraflex Company (The)**]
11) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Advanced Thermal Systems, Inc**]
2) [**Amber/Booth Company, Inc.; a VMC Group Company**]
3) [**ASC Engineered Solutions**]
4) [**Flex-Hose Co., Inc**]
5) [**Flex-Pression**]
6) [**Flex-Weld Inc., div of Kelco Industries**]
7) [**Flex-Weld; a division of Kelco**]
8) [**Flexicraft Industries**]
9) [**Hyspan Precision Products, Inc**]
10) [**Metraflex Company (The)**]
11) <**Insert manufacturer's name**>

c. Source Limitations: Obtain alignment guides from single manufacturer.
d. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.

2. Anchor Materials:

a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, [**zinc-coated carbon**][**stainless**] steel.
2) Expansion Plug: [**Zinc-coated carbon**][**Stainless**] steel.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, [**zinc-coated carbon**][**stainless**] steel with continuous thread on stud, unless otherwise indicated.
3) Washer and Nut: [**Zinc-coated carbon**][**Stainless**] steel.

2.3 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge (0.6 mm)** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GPT; a division of EnPRO Industries**]
   d. [**Metraflex Company (The)**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advance Products & Systems, LLC**]
   b. [**CALPICO, Inc.**]
   c. [**GPT; a division of EnPRO Industries**]
   d. [**Metraflex Company (The)**]
   e. <**Insert manufacturer's name**>

3. Description: Manufactured [**PVC/HDPE**][**steel**][**stainless steel**][**galvanized-steel**], sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
   b. [**Wade; a subsidiary of McWane Inc.**]
   c. [**Zurn Industries, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
b. [**Wade; a subsidiary of McWane Inc.**]
c. [**Zurn Industries, LLC**]
d. <**Insert manufacturer's name**>

3. Description: Manufactured, [**Dura-coated or Duco-coated**][**galvanized**] cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advance Products & Systems, LLC**]
b. [**Airex Manufacturing Inc.**]
c. [**CALPICO, Inc.**]
d. [**GPT; a division of EnPRO Industries**]
e. [**Metraflex Company (The)**]
f. [**Proco Products, Inc**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**Airex Manufacturing Inc.**]
c. [**CALPICO, Inc.**]
d. [**GPT; a division of EnPRO Industries**]
e. [**Metraflex Company (The)**]
f. [**Proco Products, Inc**]
g. <**Insert manufacturer's name**>

3. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

a. Hydrostatic seal: **20 psig (137 kPa) minimum)**.
b. Sealing Elements: [**EPDM-rubber**][**High-temperature-silicone**][**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
c. Pressure Plates: [**Carbon steel**][**Composite plastic**][**Stainless steel**][**Stainless steel, Type 316**].
d. Connecting Bolts and Nuts: [**Carbon steel, with zinc coating. ASTM B633**][**Stainless steel**][**Stainless steel, Type 316,**] of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-

cement grout.

3. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**ITW Polymers Sealants North America**]
      3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      4) [**Sherwin-Williams Company (The)**]
      5) [**Sika Corporation**]
      6) [**The Dow Chemical Company**]
      7) [**Tremco Incorporated**]
      8) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**GE Construction Sealants; Momentive Performance Materials Inc.**]
      2) [**ITW Polymers Sealants North America**]
      3) [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
      4) [**Sherwin-Williams Company (The)**]
      5) [**Sika Corporation**]
      6) [**The Dow Chemical Company**]
      7) [**Tremco Incorporated**]
      8) <**Insert manufacturer's name**>

   c. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, [**25**][**100/50**], pourable, [**plus 25 percent and minus 25 percent**][**plus 100 percent and minus 50 percent**] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

      1) [**Pecora Corporation**]
      2) [**Sika Corporation**]
      3) [**The Dow Chemical Company**]
      4) [**Tremco Incorporated**]
      5) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Pecora Corporation**]
2) [**Sika Corporation**]
3) [**The Dow Chemical Company**]
4) [**Tremco Incorporated**]
5) <**Insert manufacturer's name**>

c. Standard: ASTM C920, Type S, Grade P, [**Class 25**][**Class 100/50**], Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Smooth-On**]
2) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Smooth-On**]
2) <**Insert manufacturer's name**>

4. Sealant shall have a VOC content of [**250**]<**Insert value**> g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
c. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
d. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
e. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.4 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**BrassCraft Manufacturing Co.; a Masco company**]

2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**BrassCraft Manufacturing Co.; a Masco company**]
2. [**Dearborn Brass**]
3. [**Jones Stephens Corp.**]
4. [**Keeney Manufacturing Company (The)**]
5. [**Mid-America Fittings, LLC; A Midland Industries Company**]
6. [**ProFlo; a Ferguson Enterprises, Inc. brand**]
7. <**Insert manufacturer's name**>

C. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**][**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**][**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**][**and**][**exposed-rivet**] hinge; and spring-clip fasteners.

D. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

2.5 METERS AND GAUGES FOR HVAC PIPING

A. Thermometers, Bimetallic Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Blue Ribbon Corp.**]
c. [**Ernst Flow Industries**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**WATTS; A Watts Water Technologies Company**]

l. [**Weiss Instruments, Inc**]
m. [**Weksler Glass Thermometer Corp.**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Blue Ribbon Corp.**]
c. [**Ernst Flow Industries**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**WATTS; A Watts Water Technologies Company**]
l. [**Weiss Instruments, Inc**]
m. [**Weksler Glass Thermometer Corp.**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Provide bimetallic-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Liquid-filled**][**and**][**sealed**] type(s); stainless steel with [**3-inch (75-mm)**][**5-inch (125-mm)**]<**Insert dimension**> nominal diameter.
6. Dial: [**Nonreflective aluminum**]<**Insert material**> with permanently etched scale markings and scales in [**deg F (deg C)**][**deg F and deg C**].
7. Connector Type(s): Union joint, [**adjustable angle**][**rigid, back**][**and**][**rigid, bottom**]<**Insert type**>, with unified-inch screw threads.
8. Connector Size: [**1/2 inch (12 mm)**]<**Insert dimension**>, with ASME B1.1 screw threads.
9. Stem: **0.25 or 0.375 inch (6.4 or 9.5 mm)** in diameter; stainless steel.
10. Window: [**Plain glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: Stainless steel.
12. Element: Bimetal coil.
13. Pointer: Dark-colored metal.
14. Accuracy: Plus or minus [**1**][**1.5**]<**Insert number**> percent of scale range.

B. Thermometers, Filled System - Direct-Mounted, Metal-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**REOTEMP Instrument Corporation**]

f. [**Trerice, H. O. Co**]
g. [**Weiss Instruments, Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**REOTEMP Instrument Corporation**]
f. [**Trerice, H. O. Co**]
g. [**Weiss Instruments, Inc**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, direct-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical,[**dampening type,**] with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
12. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

C. Thermometers, Filled System - Direct-Mounted, Plastic-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Miljoco Corporation**]
c. [**REOTEMP Instrument Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Miljoco Corporation**]
c. [**REOTEMP Instrument Corporation**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, direct-mounted, plastic-case, vapor-actuated thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**5-inch (125-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**or**][**plastic**]<**Insert material**>.
12. Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**][**rigid, back**][**and**][**rigid, bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

D. Thermometers, Filled-System - Remote-Mounted, Metal-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Marsh Bellofram**]
    e. [**Miljoco Corporation**]
    f. [**Palmer Wahl Instrumentation Group**]
    g. [**REOTEMP Instrument Corporation**]
    h. [**Trerice, H. O. Co**]
    i. [**Weiss Instruments, Inc**]
    j. [**WIKA Instrument Corporation**]
    k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Marsh Bellofram**]

e. [**Miljoco Corporation**]
f. [**Palmer Wahl Instrumentation Group**]
g. [**REOTEMP Instrument Corporation**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, remote-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
4. Standard: ASME B40.200.
5. Case: Sealed type, [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
12. Connector Type(s): Union joint, [**back**][**bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus [**1**]<**Insert number**> percent of scale range.

E. Thermometers, Filled System - Remote-Mounted, Plastic-Case, Vapor-Actuated:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Miljoco Corporation**]
    d. [**REOTEMP Instrument Corporation**]
    e. [**Trerice, H. O. Co**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Miljoco Corporation**]
    d. [**REOTEMP Instrument Corporation**]
    e. [**Trerice, H. O. Co**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Provide filled-system, remote-mounted, plastic-case, vapor-actuated

thermometers from a single manufacturer.

4. Standard: ASME B40.200.
5. Case: Sealed type, [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Element: Bourdon tube or other type of pressure element.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
11. Ring: [**Metal**][**or**][**plastic**]<**Insert material**>.
12. Connector Type(s): Union joint, threaded, [**back**][**bottom**]; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

14. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

F. Thermometers, Liquid-in-Glass - Metal Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Miljoco Corporation**]
    b. [**Trerice, H. O. Co**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, metal-case, compact-style thermometers by single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Cast aluminum**]<**Insert material**>; **6-inch (150-mm)** nominal size.
6. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: Glass or plastic.
10. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Connector: **3/4 inch (19 mm)**, with ASME B1.1 screw threads.

12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

G. Thermometers, Liquid in Glass - Plastic Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Flo Fab Inc**]
    c. [**Miljoco Corporation**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Weiss Instruments, Inc**]
    f. [**Weksler Glass Thermometer Corp.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Blue Ribbon Corp.**]
    b. [**Flo Fab Inc**]
    c. [**Miljoco Corporation**]
    d. [**WATTS; A Watts Water Technologies Company**]
    e. [**Weiss Instruments, Inc**]
    f. [**Weksler Glass Thermometer Corp.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, plastic-case, compact-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Plastic**]<**Insert material**>; **6-inch (150-mm)** nominal size.
6. Case Form: [**Back angle**][**Straight**] unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: Glass or plastic.
10. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Connector: **3/4 inch (19 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

H. Thermometers, Liquid in Glass - Metal Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]

b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**Trerice, H. O. Co**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Ribbon Corp.**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**Trerice, H. O. Co**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, metal-case, industrial-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Cast aluminum**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
6. Case Form: [**Adjustable angle**][**Back angle**][**Straight**]<**Insert form**> unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
10. Stem: [**Aluminum**]<**Insert material**> and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

11. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

I. Thermometers, Liquid in Glass - Plastic Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ernst Flow Industries**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Weiss Instruments, Inc**]

g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ernst Flow Industries**]
b. [**Marsh Bellofram**]
c. [**Miljoco Corporation**]
d. [**Palmer Wahl Instrumentation Group**]
e. [**WATTS; A Watts Water Technologies Company**]
f. [**Weiss Instruments, Inc**]
g. [**Weksler Glass Thermometer Corp.**]
h. [**Winters Instruments - U.S.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Provide liquid-in-glass, plastic-case, industrial-style thermometers from single manufacturer.
4. Standard: ASME B40.200.
5. Case: [**Plastic**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
6. Case Form: [**Adjustable angle**][**Back angle**][**Straight**]<**Insert form**> unless otherwise indicated.
7. Tube: Glass with magnifying lens and blue[**or red**] organic liquid.
8. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**][**deg F and deg C**].
9. Window: [**Glass**][**or**][**plastic**]<**Insert material**>.
10. Stem: [**Aluminum**][**Brass**][**Stainless steel**][**Aluminum, brass, or stainless steel**]<**Insert material**> and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

11. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 screw threads.
12. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

J. Thermometers, Light Activated - Direct Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Miljoco Corporation**]
b. [**Trerice, H. O. Co**]
c. [**Weiss Instruments, Inc**]
d. [**Weksler Glass Thermometer Corp.**]
e. [**Winters Instruments - U.S.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Miljoco Corporation**]
b. [**Trerice, H. O. Co**]
c. [**Weiss Instruments, Inc**]
d. [**Weksler Glass Thermometer Corp.**]
e. [**Winters Instruments - U.S.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Provide light-activated, direct-mounted thermometers from single manufacturer.
4. Case: [**Plastic**][**Metal**]<**Insert material**>; [**7-inch (180-mm)**][**9-inch (230-mm)**] nominal size unless otherwise indicated.
5. Scale(s): [**Deg F (deg C)**][**Deg F and deg C**].
6. Case Form: [**Adjustable angle**]<**Insert form**>.
7. Connector: [**1-1/4 inches (32 mm)**]<**Insert dimension**>, with ASME B1.1 screw threads.
8. Stem: [**Aluminum**]<**Insert material**> and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

9. Display: Digital.
10. Accuracy: Plus or minus **2 deg F (1 deg C)**.

K. Thermometers, Light Activated - Remote Mounted:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Miljoco Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Miljoco Corporation**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Provide light-activated, remote-mounted thermometers from single manufacturer.
4. Case: Plastic, for wall mounting.
5. Scale(s): [**Deg F (deg C)**][**Deg F and deg C**].
6. Sensor: Bulb and thermister wire.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

7. Display: Digital.
8. Accuracy: Plus or minus **2 deg F (1 deg C)**.

L. Duct-Thermometer Mounting Brackets:

1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

M. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: [**CNR**][**or**][**CUNI**]<**Insert material**>.
4. Material for Use with Steel Piping: [**CRES**][**CSA**]<**Insert material**>.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: **NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,)** ASME B1.20.1 pipe threads.
7. Internal Threads: **1/2, 3/4, and 1 inch (13, 19, and 25 mm)**, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: [**Mixture of graphite and glycerin**]<**Insert material**>.

N. Pressure Gauges, Dial Type - Direct Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Ernst Flow Industries**]
    e. [**Flo Fab Inc**]
    f. [**Marsh Bellofram**]
    g. [**Miljoco Corporation**]
    h. [**Noshok**]
    i. [**Palmer Wahl Instrumentation Group**]
    j. [**REOTEMP Instrument Corporation**]
    k. [**Tel-Tru Manufacturing Company**]
    l. [**Trerice, H. O. Co**]
    m. [**WATTS; A Watts Water Technologies Company**]
    n. [**Weiss Instruments, Inc**]
    o. [**Weksler Glass Thermometer Corp.**]
    p. [**WIKA Instrument Corporation**]
    q. [**Winters Instruments - U.S.**]
    r. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Ametek U.S. Gauge**]
    b. [**Ashcroft Inc**]
    c. [**Blue Ribbon Corp.**]
    d. [**Ernst Flow Industries**]
    e. [**Flo Fab Inc**]
    f. [**Marsh Bellofram**]
    g. [**Miljoco Corporation**]
    h. [**Noshok**]
    i. [**Palmer Wahl Instrumentation Group**]

j. [**REOTEMP Instrument Corporation**]
k. [**Tel-Tru Manufacturing Company**]
l. [**Trerice, H. O. Co**]
m. [**WATTS; A Watts Water Technologies Company**]
n. [**Weiss Instruments, Inc**]
o. [**Weksler Glass Thermometer Corp.**]
p. [**WIKA Instrument Corporation**]
q. [**Winters Instruments - U.S.**]
r. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, direct-mounted, metal-case pressure gauges from single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Liquid-filled**][**Sealed**][**Open-front, pressure-relief**][**Solid-front, pressure-relief**]<**Insert type**> type(s); [**cast aluminum or drawn steel**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi**|**START_SI**|**(kPa)**][|**END_SI**|**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Ring: [**Metal**][**Brass**][**Stainless steel**]<**Insert material**>.
13. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

O. Pressure Gauges, Dial Type - Direct Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ametek U.S. Gauge**]
   b. [**Ashcroft Inc**]
   c. [**Flo Fab Inc**]
   d. [**Marsh Bellofram**]
   e. [**Miljoco Corporation**]
   f. [**Noshok**]
   g. [**Palmer Wahl Instrumentation Group**]
   h. [**REOTEMP Instrument Corporation**]
   i. [**Tel-Tru Manufacturing Company**]
   j. [**Trerice, H. O. Co**]
   k. [**Weiss Instruments, Inc**]
   l. [**Weksler Glass Thermometer Corp.**]
   m. [**WIKA Instrument Corporation**]
   n. [**Winters Instruments - U.S.**]
   o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Flo Fab Inc**]
d. [**Marsh Bellofram**]
e. [**Miljoco Corporation**]
f. [**Noshok**]
g. [**Palmer Wahl Instrumentation Group**]
h. [**REOTEMP Instrument Corporation**]
i. [**Tel-Tru Manufacturing Company**]
j. [**Trerice, H. O. Co**]
k. [**Weiss Instruments, Inc**]
l. [**Weksler Glass Thermometer Corp.**]
m. [**WIKA Instrument Corporation**]
n. [**Winters Instruments - U.S.**]
o. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, direct-mounted, plastic-case pressure gauges from a single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Sealed**]<**Insert type**> type; [**plastic**]<**Insert material**>; [**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

P. Pressure Gauges, Dial Type - Remote Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Ernst Flow Industries**]
d. [**Flo Fab Inc**]
e. [**Marsh Bellofram**]
f. [**Miljoco Corporation**]
g. [**Noshok**]
h. [**Palmer Wahl Instrumentation Group**]
i. [**REOTEMP Instrument Corporation**]
j. [**Tel-Tru Manufacturing Company**]
k. [**Trerice, H. O. Co**]
l. [**WATTS; A Watts Water Technologies Company**]
m. [**Weiss Instruments, Inc**]

n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ametek U.S. Gauge**]
b. [**Ashcroft Inc**]
c. [**Ernst Flow Industries**]
d. [**Flo Fab Inc**]
e. [**Marsh Bellofram**]
f. [**Miljoco Corporation**]
g. [**Noshok**]
h. [**Palmer Wahl Instrumentation Group**]
i. [**REOTEMP Instrument Corporation**]
j. [**Tel-Tru Manufacturing Company**]
k. [**Trerice, H. O. Co**]
l. [**WATTS; A Watts Water Technologies Company**]
m. [**Weiss Instruments, Inc**]
n. [**WIKA Instrument Corporation**]
o. [**Winters Instruments - U.S.**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, remote-mounted, metal-case pressure gauges from a single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Liquid-filled**][**Sealed**]<**Insert type**> type; [**cast aluminum or drawn steel**][**metal**]<**Insert material**>; [**3-1/2-inch (90-mm)**][**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Ring: [**Metal**][**Stainless steel**]<**Insert material**>.
13. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

Q. Pressure Gauges, Dial Type - Remote Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ashcroft Inc**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]

d. [**Noshok**]
e. [**Palmer Wahl Instrumentation Group**]
f. [**REOTEMP Instrument Corporation**]
g. [**Tel-Tru Manufacturing Company**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ashcroft Inc**]
b. [**Flo Fab Inc**]
c. [**Miljoco Corporation**]
d. [**Noshok**]
e. [**Palmer Wahl Instrumentation Group**]
f. [**REOTEMP Instrument Corporation**]
g. [**Tel-Tru Manufacturing Company**]
h. [**Trerice, H. O. Co**]
i. [**Weiss Instruments, Inc**]
j. [**WIKA Instrument Corporation**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Provide dial-type, remote-mounted, plastic-case pressure gauges from single manufacturer.
4. Standard: ASME B40.100.
5. Case: [**Sealed**]<**Insert type**> type; [**plastic**]<**Insert material**>; [**3-1/2-inch (90-mm)**][**4-1/2-inch (115-mm)**][**6-inch (150-mm)**]<**Insert dimension**> nominal diameter with [**back**][**front**] flange and holes for panel mounting.
6. Pressure-Element Assembly: Bourdon tube.
7. Pressure Connection: Brass, with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi (kPa)**][**psi and kPa**].
10. Pointer: Dark-colored metal.
11. Window: [**Glass**][**Safety glass**][**or**][**acrylic plastic**]<**Insert material**>.
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**][**Grade B, plus or minus 2 percent of middle half of**][**Grade C, plus or minus 3 percent of middle half of**][**Grade D, plus or minus 5 percent of whole**] span.

R. Gauge Attachments:

1. Snubbers: ASME B40.100, brass; with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads and [**piston**][**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of [**brass**][**stainless steel**][**steel**] pipe with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**] pipe threads.
3. Valves: [**Brass ball**][**Brass or stainless steel needle**], with [**NPS 1/4 (DN 8)**][**NPS 1/4 or NPS 1/2 (DN 8 or DN 15)**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe threads.

S. Test Plugs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**IMI Flow Design, Inc.**]
    b. [**Miljoco Corporation**]
    c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
    d. [**Peterson Equipment Co., Inc**]
    e. [**Trerice, H. O. Co**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Weiss Instruments, Inc**]
    h. [**Weksler Glass Thermometer Corp.**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**IMI Flow Design, Inc.**]
    b. [**Miljoco Corporation**]
    c. [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
    d. [**Peterson Equipment Co., Inc**]
    e. [**Trerice, H. O. Co**]
    f. [**WATTS; A Watts Water Technologies Company**]
    g. [**Weiss Instruments, Inc**]
    h. [**Weksler Glass Thermometer Corp.**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Provide test plugs from single manufacturer.
4. Description: Test-station fitting made for insertion in piping tee fitting.
5. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
6. Thread Size: [**NPS 1/4 (DN 8)**][**or**][**NPS 1/2 (DN 15)**], ASME B1.20.1 pipe thread.
7. Minimum Pressure and Temperature Rating: [**500 psig at 200 deg F (3450 kPa at 93 deg C)**]<**Insert ratings**>.
8. Core Inserts: [**Chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber.

T. Test-Plug Kits:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Blue Ribbon Corp.**]
    b. [**Peterson Equipment Co., Inc**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Blue Ribbon Corp.**]
    b. [**Peterson Equipment Co., Inc**]

c. **<Insert manufacturer's name>**

3. Source Limitations: Provide test-plug kits from single manufacturer.
4. Furnish [**one**]<**Insert number**> test-plug kit(s) containing [**one**][**two**] thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.
5. Low-Range Thermometer: Small, bimetallic insertion type with [**1- to 2-inch- (25- to 50-mm-)**]<**Insert dimension**> diameter dial and tapered-end sensing element. Dial range is to be at least [**25 to 125 deg F (minus 4 to plus 52 deg C)**]<**Insert temperature range**>.
6. High-Range Thermometer: Small, bimetallic insertion type with [**1- to 2-inch- (25- to 50-mm-)**]<**Insert dimension**> diameter dial and tapered-end sensing element. Dial range is to be at least [**0 to 220 deg F (minus 18 to plus 104 deg C)**]<**Insert temperature range**>.
7. Pressure Gauge: Small, Bourdon-tube insertion type with [**2- to 3-inch- (50- to 75-mm-)**]<**Insert dimension**> diameter dial and probe. Dial range shall be at least [**0 to 200 psig (0 to 1380 kPa)**]<**Insert range**>.
8. Carrying Case: Metal or plastic, with formed instrument padding.

U. Sight Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARCHON Industries, Inc**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Ernst Flow Industries**]
   d. [**John C. Ernst Co., Inc.**]
   e. [**KOBOLD Instruments, Inc. - USA**]
   f. [**OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARCHON Industries, Inc**]
   b. [**Dwyer Instruments, Inc**]
   c. [**Ernst Flow Industries**]
   d. [**John C. Ernst Co., Inc.**]
   e. [**KOBOLD Instruments, Inc. - USA**]
   f. [**OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company**]
   g. **<Insert manufacturer's name>**

3. Source Limitations: Provide sight flow indicators from single manufacturer.
4. Description: Piping inline-installation device for visual verification of flow.
5. Construction: Bronze or stainless steel body, with sight glass and [**ball, flapper, or paddle wheel**]<**Insert device**> indicator, and threaded or flanged ends.
6. Minimum Pressure Rating: [**125 psig (860 kPa)**][**150 psig (1034 kPa)**]<**Insert value**>.
7. Minimum Temperature Rating: [**200 deg F (93 deg C)**]<**Insert temperature**>.
8. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
9. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

V. Flowmeters:

1. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
2. Flowmeters - Orifice:

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

        1) [**ABB, Process Automation Business**]
        2) [**Armstrong International, Inc**]
        3) [**Bell & Gossett; a Xylem brand**]
        4) [**Meriam Process Technologies**]
        5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
        6) <**Insert manufacturer's name**>

    b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

        1) [**ABB, Process Automation Business**]
        2) [**Armstrong International, Inc**]
        3) [**Bell & Gossett; a Xylem brand**]
        4) [**Meriam Process Technologies**]
        5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
        6) <**Insert manufacturer's name**>

    c. Source Limitations: Provide orifice flowmeters from single manufacturer.
    d. Description: Flowmeter with orifice plate and flanges, differential pressure sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
    e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
    f. Orifice Plate: Wafer-orifice-type, calibrated, flow-measuring element; for installation between orifice plate pipe flanges.

        1) Design: Differential-pressure-type measurement for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
        2) Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
        3) Minimum Pressure Rating: [**300 psig (2070 kPa)**]<**Insert value**>.
        4) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.

    g. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor, and has **6-inch- (150-mm-)** diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.

        1) Scale Divisions: <**Insert value**>[**gpm**|**START_SI| (Lps)**][**gpm and Lps**]END_SI.
        2) Accuracy: Plus or minus [**1 percent between 20 and 80 percent of scale range**]<**Insert accuracy**>.

    h. Portable Indicators: Handheld, differential-pressure type, calibrated for connected sensor and having two **12 ft. (3.7 m)** hoses, with carrying case.

        1) Scale Divisions: <**Insert value**>[**gpm**|**START_SI| (Lps)**][**gpm and Lps**]END_SI.
        2) Accuracy: Plus or minus [**2 percent between 20 and 80 percent of scale**

range]<**Insert accuracy**>.

i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Conversion Chart: Flow rate data compatible with sensor and indicator.
k. Operating Instructions: Include complete instructions with each flowmeter.

3. Flowmeters - Pitot Tube:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Meriam Process Technologies**]
3) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
6) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Meriam Process Technologies**]
3) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Rosemount; Emerson Electric Co., Automation Solutions**]
6) <**Insert manufacturer's name**>

c. Source Limitations: Provide pitot-tube flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Insertion type; for inserting probe in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Differential-pressure-type measurement for [**oil**][**water**]<**Insert fluid**>.
2) Construction: Stainless steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provide way to permit removal of probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Integral Transformer: For low-voltage power connection.
i. Accuracy: Plus or minus [**3**]<**Insert number**> percent.
j. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
k. Operating Instructions: Include complete instructions with each flowmeter.

4. Flowmeters - Turbine:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

1) [**ERDCO Engineering Corp**]
2) [**Hoffer Flow Controls, Inc**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**SeaMetrics, Inc.**]
6) [**Spirax Sarco Limited**]
7) [**Veris Industries**]
8) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ERDCO Engineering Corp**]
2) [**Hoffer Flow Controls, Inc**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**SeaMetrics, Inc.**]
6) [**Spirax Sarco Limited**]
7) [**Veris Industries**]
8) <**Insert manufacturer's name**>

c. Source Limitations: Provide turbine flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
2) Construction: Bronze or stainless steel body, with plastic turbine or impeller.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provide way to permit removal of probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**180 deg F (82 deg C)**]<**Insert temperature**>.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Accuracy: Plus or minus [**1-1/2**]<**Insert number**> percent.
i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Operating Instructions: Include complete instructions with each flowmeter.

5. Flowmeters - Venturi:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Gerand Engineering Co**]
3) [**Hyspan Precision Products, Inc**]

4) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
5) [**Preso Meters; Badger Meter Inc.**]
6) [**Rosemount; Emerson Electric Co., Automation Solutions**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Gerand Engineering Co**]
3) [**Hyspan Precision Products, Inc**]
4) [**Nexus Valve, Inc.; Aalberts Hydronic Flow Control**]
5) [**Preso Meters; Badger Meter Inc.**]
6) [**Rosemount; Emerson Electric Co., Automation Solutions**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Provide venture flowmeters from single manufacturer.
d. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Flow-Measuring Element:

1) Design: Differential-pressure-type measurement for [**gas**][**oil**][**steam**][**water**]<**Insert fluid**>.
2) Venturi type with [**in-line**][**or**][**insertion**] element.
3) Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
4) Minimum Pressure Rating: [**250 psig (1725 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**250 deg F (121 deg C)**]<**Insert temperature**>.
6) End Connections for NPS 2 (DN 50) and Smaller: Threaded.
7) End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
8) Flow Range: Flow-measuring element and flowmeter are to cover operating range of equipment or system served.

g. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and has **6-inch- (150-mm-)** diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

1) Scale: <**Insert value**> **gpm (Lps)**.
2) Accuracy: Plus or minus [**1 percent between 20 and 80 percent of scale range**]<**Insert accuracy**>.

h. Portable Indicators: Handheld, differential-pressure type, calibrated for connected flowmeter element and has two **12 ft. (3.7 m)** hoses, with carrying case.

1) Scale: <**Insert value**> **gpm (Lps)**.
2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Conversion Chart: Flow rate data compatible with sensor.
k. Operating Instructions: Include complete instructions with each flowmeter.

6. Flowmeters - Vortex Shedding:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ABB, Process Automation Business**]
2) [**Endress+Hauser**]
3) [**ISTEC Corporation**]
4) [**Rosemount; Emerson Electric Co., Automation Solutions**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ABB, Process Automation Business**]
2) [**Endress+Hauser**]
3) [**ISTEC Corporation**]
4) [**Rosemount; Emerson Electric Co., Automation Solutions**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Provide vortex-shedding flowmeters from single manufacturer.
d. Description: Flowmeter with sensor and indicator.
e. Flow Range: Sensor and indicator are to cover operating range of equipment or system served.
f. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in **gpm (Lps)**.

1) Design: Flow-obstruction device, vortex-measurement type for [**gas**][**steam**][**and**][**liquids**].
2) Construction: Stainless steel body, with integral transmitter and direct-reading scale.
3) Minimum Pressure Rating: [**1000 psig (6900 kPa)**]<**Insert value**>.
4) Minimum Temperature Rating: [**500 deg F (260 deg C)**]<**Insert temperature**>.
5) Integral Transformer: For low-voltage power operation.

g. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
h. Accuracy: Plus or minus [**0.25**]<**Insert number**> percent for liquids and [**0.75**]<**Insert number**> percent for gases.
i. Display: Shows rate of flow[**, with register to indicate total volume in gallons (liters)**].
j. Operating Instructions: Include complete instructions with each flowmeter.

7. Thermal-Energy Meters - Turbine:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**ISTEC Corporation**]
2) [**ONICON Incorporated**]
3) [**Preso Meters; Badger Meter Inc.**]
4) [**Veris Industries**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**ISTEC Corporation**]
2) [**ONICON Incorporated**]
3) [**Preso Meters; Badger Meter Inc.**]
4) [**Veris Industries**]
5) <**Insert manufacturer's name**>

c. Source Limitations: Provide turbine thermal-energy meters from single manufacturer.
d. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
e. Description: System with[**strainer,**] flow sensor, two temperature sensors, transmitter, indicator, and connecting wiring.
f. Flow Sensor: Turbine type; for inserting in pipe fitting or for installing in piping and measuring flow directly in **gpm (Lps)**.

1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for [**gas**][**oil**][**steam**][**water**].
2) Construction: Bronze or stainless steel body, with plastic turbine or impeller.
3) Fitting for mounting probe in pipe, with [**weld**][**or**][**threaded**] connection for attachment to pipe. Provision to remove probe for service.
4) Minimum Pressure Rating: [**150 psig (1035 kPa)**]<**Insert value**>.
5) Minimum Temperature Rating: [**180 deg F (82 deg C)**]<**Insert temperature**>.

g. Temperature Sensors: Insertion-type sensor-transducer.
h. Indicator: Solid-state, integrating-type meter[**with integral battery pack**]; for wall mounting.

1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or **British thermal units (joules)**.
2) Battery Pack: Five-year lithium battery.

i. Accuracy: Plus or minus [**1**]<**Insert number**> percent.
j. Display: Visually indicates total fluid volume in **gallons (liters)** and thermal-energy flow in kilowatts per hour or **British thermal units (joules)**.
k. Strainer: Full size of main line piping.
l. Operating Instructions: Include complete instructions with each thermal-energy meter system.

8. Thermal-Energy Meters - Ultrasonic:

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Armstrong International, Inc**]
2) [**Badger Meter, Inc.**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Siemens Industry, Inc., Energy Management Division**]
6) [**Veris Industries**]
7) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

1) [**Armstrong International, Inc**]
2) [**Badger Meter, Inc.**]
3) [**ONICON Incorporated**]
4) [**Preso Meters; Badger Meter Inc.**]
5) [**Siemens Industry, Inc., Energy Management Division**]
6) [**Veris Industries**]
7) <**Insert manufacturer's name**>

c. Source Limitations: Provide ultrasonic thermal-energy meters from single manufacturer.
d. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
e. Description: Meter with flow sensor, two temperature sensors, transmitter, indicator, and connecting wiring.
f. Flow Sensor: Transit-time ultrasonic type with transmitter.
g. Temperature Sensors: Insertion-type or strap-on transducer.
h. Indicator: Solid-state, integrating-type meter[**with integral battery pack**].

1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or **British thermal units (joules)**.
2) Battery Pack: Five-year lithium battery.

i. Accuracy: Plus or minus [**1**]<**Insert number**> percent.
j. Display: Visually indicates total fluid volume in **gallons (liters)** and thermal-energy flow in kilowatts per hour or **British thermal units (joules)**.
k. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS - GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKED EXPANSION JOINTS

A. Install packed expansion joints with packing suitable for fluid service.

3.3 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows packless expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.4 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

A. Install grooved-joint expansion joints to grooved-end steel piping.

3.5 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install [**one**][**two**] guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than [**four**]<**Insert number**> pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.6 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least [**five**]<**Insert number**> pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least [**four**]<**Insert number**> pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least [**four**]<**Insert number**> pipe fittings, including tee in main.

3.7 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch (25-mm)**][**2-inch (50-mm)**]<**Insert dimension**> annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches (50 mm)**]<**Insert dimension**> above finished floor level.

3. Using [**grout**][**or**][**silicone sealant**], seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.8 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using [**grout**][**or**][**silicone sealant**], seal space around outside of sleeves.

3.9 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to **3 inches (76 mm)** above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.10 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.11 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.12 INSTALLATION OF METERS AND GAUGES

A. Install thermowells with socket extending [**a minimum of 2 inches (50 mm) into fluid**][**one-third of pipe diameter**][**to center of pipe**] and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator.

H. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.

I. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

J. Install remote-mounted pressure gauges on panel.

K. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

L. Install valve and syphon fitting in piping for each pressure gauge for steam.

M. Install test plugs in piping tees.

N. Install flow indicators in piping systems in accessible positions for easy viewing.

O. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

P. Install flowmeter elements in accessible positions in piping systems.

Q. Install wafer-orifice flowmeter elements between orifice-type pipe flanges.

R. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

S. Install permanent indicators on walls or brackets in accessible and readable positions.

T. Install connection fittings in accessible locations for attachment to portable indicators.

U. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

V. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.
8. <**Insert location**>.

W. Install pressure gauges in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.
4. <**Insert location**>.

3.13 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.14 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.15 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.16 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**]<**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch (25-mm)**]<**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [**Sleeves with waterstops**][**or**][**stack-sleeve fittings**].

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.17 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, [**steel**][**cast brass**][**or split-plate steel**] with polished, chrome-plated finish.

3. Insulated Piping:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One piece, steel with [**polished, chrome-plated**][**polished brass**] finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with [**polished, chrome-plated**][**polished brass**] finish.
    d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
    c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with [**polished, chrome-plated**][**rough-brass**] finish.
    c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**][**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [**concealed**][**or**][**exposed-rivet**] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.18 THERMOMETER APPLICATION

A. Thermometers at inlet and outlet of each hydronic zone are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic boiler are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Thermometers at inlets and outlets of each chiller are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

E. Thermometers at inlets and outlets of each hydronic heat exchanger are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

F. Thermometers at inlet and outlet of each hydronic heat-recovery unit are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.

5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

G. Thermometers at inlet and outlet of each thermal-storage tank are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

H. Thermometers at outside-, return-, supply-, and mixed-air ducts are to be the following:

1. [**Liquid-filled**][**Sealed**], bimetallic-actuated type.
2. [**Direct**][**Remote**]-mounted, [**metal**][**plastic**]-case, vapor-actuated type.
3. [**Compact**][**Industrial**]-style, liquid-in-glass type.
4. [**Direct**][**Remote**]-mounted, light-activated type.

I. Thermometer stems are to be of length to match thermowell insertion length.

3.19 THERMOMETER SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. [**Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C)**][**Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C**].
2. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
3. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
4. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].

B. Scale Range for Condenser-Water Piping:

1. [**0 to 100 deg F (Minus 20 to plus 50 deg C)**][**0 to 100 deg F and minus 20 to plus 50 deg C**].
2. [**0 to 150 deg F (Minus 20 to plus 70 deg C)**][**0 to 150 deg F and minus 20 to plus 70 deg C**].
3. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
4. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**].
5. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].

C. Scale Range for Heating, Hot-Water Piping:

1. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
2. [**20 to 240 deg F (0 to 150 deg C)**][**20 to 240 deg F and 0 to 150 deg C**] .
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].
4. [**50 to 400 deg F (0 to 200 deg C)**][**50 to 400 deg F and 0 to 200 deg C**].
5. [**50 to 550 deg F (10 to 300 deg C)**][**50 to 550 deg F and 10 to 300 deg C**].

D. Scale Range for Steam and Steam-Condensate Piping:

1. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
2. [**0 to 250 deg F (0 to 150 deg C)**][**0 to 250 deg F and 0 to 150 deg C**].
3. [**30 to 240 deg F (0 to plus 115 deg C)**][**30 to 240 deg F and 0 to plus 115 deg C**].
4. [**50 to 400 deg F (0 to 200 deg C)**][**50 to 400 deg F and 0 to 200 deg C**].

E. Scale Range for Air Ducts:

1. [Minus 40 to plus 110 deg F (Minus 40 to plus 45 deg C)][Minus 40 to plus 110 deg F and minus 40 to plus 45 deg C].
2. [Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C)][Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C].
3. [0 to 100 deg F (Minus 20 to plus 50 deg C)][0 to 100 deg F and minus 20 to plus 50 deg C].
4. [0 to 150 deg F (Minus 20 to plus 70 deg C)][0 to 150 deg F and minus 20 to plus 70 deg C].
5. [0 to 250 deg F (0 to 150 deg C)][0 to 250 deg F and 0 to 150 deg C].
6. [20 to 240 deg F (0 to 150 deg C)][20 to 240 deg F and 0 to 150 deg C].
7. [30 to 240 deg F (0 to plus 115 deg C)][30 to 240 deg F and 0 to plus 115 deg C].
8. [50 to 400 deg F (0 to 200 deg C)][50 to 400 deg F and 0 to 200 deg C].

3.20 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each pressure-reducing valve are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each chiller chilled-water and condenser-water connection are to be the following:

1. [**Liquid filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each pump are to be the following:

1. [**Liquid-filled**][**Sealed**][**Open front, pressure relief**][**Solid front, pressure relief**]<**Insert type**>, [**direct**][**remote**] mounted, metal case.
2. [**Sealed**]<**Insert type**>, [**direct**][**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**][**EPDM**] self-sealing rubber inserts.

3.21 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. [30 in. Hg to 15 psi (minus 100 to 0 kPa)][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [0 to 30 psi (0 to 240 kPa)][**0 to 30 psi and 0 to 240 kPa**].
3. [0 to 100 psi (0 to 600 kPa)][**0 to 100 psi and 0 to 600 kPa**].
4. [0 to 160 psi (0 to 1100 kPa)][**0 to 160 psi and 0 to 1100 kPa**].
5. [0 to 200 psi (0 to 1400 kPa)][**0 to 200 psi and 0 to 1400 kPa**].
6. [0 to 300 psi (0 to 2500 kPa)][**0 to 300 psi and 0 to 2500 kPa**].
7. [0 to 600 psi (0 to 4000 kPa)][**0 to 600 psi and 0 to 4000 kPa**].

B. Scale Range for Condenser-Water Piping:

1. [30 in. Hg to 15 psi (minus 100 to 0 kPa)][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [0 to 30 psi (0 to 240 kPa)][**0 to 30 psi and 0 to 240 kPa**].
3. [0 to 100 psi (0 to 600 kPa)][**0 to 100 psi and 0 to 600 kPa**].
4. [0 to 160 psi (0 to 1100 kPa)][**0 to 160 psi and 0 to 1100 kPa**].
5. [0 to 200 psi (0 to 1400 kPa)][**0 to 200 psi and 0 to 1400 kPa**].

6. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi (0 to 4000 kPa)**][**0 to 600 psi and 0 to 4000 kPa**].

C. Scale Range for Heating, Hot-Water Piping:

1. [**30 in. Hg to 15 psi (minus 100 to 0 kPa)**][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi (0 to 240 kPa)**][**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi (0 to 4000 kPa)**][**0 to 600 psi and 0 to 4000 kPa**].

D. Scale Range for Steam Piping:

1. [**30 in. Hg to 15 psi (minus 100 to 0 kPa)**][**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi (0 to 240 kPa)**][**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi (0 to 600 kPa)**][**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi (0 to 1100 kPa)**][**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi (0 to 1400 kPa)**][**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi (0 to 2500 kPa)**][**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi (0 to 4000 kPa)**][**0 to 600 psi and 0 to 4000 kPa**].

3.22 FLOWMETER APPLICATION

A. Flowmeters for Chilled-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

B. Flowmeters for Condenser-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

C. Flowmeters for Heating, Hot-Water Piping: [**Orifice**][**Pitot-tube**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

D. Flowmeters for Steam and Steam-Condensate Piping: [**Orifice**][**Turbine**][**Venturi**][**Vortex-shedding**] type.

3.23 THERMAL-ENERGY METER APPLICATION

A. Thermal-Energy Meters for Chilled-Water Piping: [**Turbine**][**Ultrasonic**] type.

B. Thermal-Energy Meters for Condenser-Water Piping: [**Turbine**][**Ultrasonic**] type.

C. Thermal-Energy Meters for Heating, Hot-Water Piping: [**Turbine**][**Ultrasonic**] type.

D. Thermal-Energy Meters for Steam and Steam-Condensate Piping: [**Turbine**][**Ultrasonic**] type.

END OF SECTION 07 63 00 00B

Task	Specification	Specification Description
07 63 00 00	07 62 00 00	Sheet Metal Flashing And Trim

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SECTION 07 65 16 00 - BUILT-UP ASPHALT ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Built-up asphalt roofing (BUR) system.
2. Roofing membrane sheet materials.
3. Base flashing sheet.
4. Asphalt materials.
5. Accessory roofing system materials.
6. Substrate board.
7. Vapor retarder.
8. Roof insulation and accessories.
9. Cover board.
10. Electronic leak-detection (ELD) materials.
11. Roof coating system.
12. Walkways.

B. Section contains installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured metal copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner,[**Construction Manager,**] Architect, the Owner's insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and roofing terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of steel roof deck and roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Crickets, saddles, and tapered edge strips, including slopes.
7. Insulation-fastening patterns for corner, perimeter, and field-of-roof locations.
8. Tie-in with adjoining air barrier.

C. Samples for Verification: For the following products, as directed by the Owner:

1. Cap Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
2. Base Flashing Sheet: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
3. Roof Coating System: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].
4. Walkways: Samples of [**manufacturer's standard colors for selection by Architect**][**specified color**].

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, for tests performed by an independent, qualified testing agency indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roof membrane manufacturer, stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in accordance with roofing system manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit Roofing System Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membranes, base flashing sheet,[**walkway products,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roof membrane to resist impact damage when tested in accordance with ASTM D3746/C3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical to that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 BUILT-UP ASPHALT ROOFING (BUR) SYSTEM

A. BUR Roofing System Components: See the following articles for individual roof materials required.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Building Products of Canada Corp.**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**IKO Industries Inc.**]
f. [**Johns Manville; a Berkshire Hathaway company**]
g. [**Malarkey Roofing Products**]
h. [**Tamko Building Products LLC**]
i. [**Tremco Incorporated**]

2.4 ROOFING MEMBRANE SHEET MATERIALS

A. SBS-Modified-Bitumen, Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, [**Type I**][**Type II**][**Type III**], SBS-modified asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.

B. Asphalt-Coated, Glass-Fiber-Mat Base Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

C. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II, venting, nonperforated, asphalt-impregnated and -coated, glass-fiber base sheet with mineral granule surfacing on bottom surface.

D. Asphalt-Coated, Organic-Felt Base Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

E. Ply Sheet: ASTM D2178/D2178M, [**Type IV**][**Type VI**], asphalt-impregnated, glass-fiber felt.

F. Cap Sheet: ASTM D3909/D3909M, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.

2.5 BASE FLASHING SHEET

A. Asphalt-Impregnated, Glass-Fiber-Mat Backer Sheet: ASTM D2178/D2178M, [**Type IV**][**Type VI**], asphalt-impregnated, glass-fiber felt.

B. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, [**Type I**][**Type II**], asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

C. Asphalt-Coated, Organic-Felt Backer Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

D. SBS-Modified-Bitumen Backer Sheet: [**ASTM D6164/D6164M, Type I or II, Grade S, reinforced with polyester fabric**][**ASTM D6163/D6163M, Type I or II, Grade S, reinforced with glass fibers**][**ASTM D6162/D6162M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers**]; smooth surfaced; suitable for application method specified.

E. SBS-Modified-Bitumen, Granule-Surfaced Flashing Sheet: [**ASTM D6164/D6164M, Type I or II, Grade G, polyester reinforced**][**ASTM D6163/D6163M, Type I or II, Grade G, glass-fiber reinforced**][**ASTM D6162/D6162M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers**], granule-surfaced; suitable for application method specified, and as follows:

1. Granule Color: [**White**][**Gray**][**Tan**].

F. SBS-Modified-Bitumen, Metal-Surfaced Flashing Sheet: ASTM D6298, glass-fiber-reinforced, SBS-modified, metal-foil-surfaced asphalt sheet, suitable for application method specified, and as follows:

1. Metal Surfacing: [**Aluminum**][**Copper**][**Stainless steel**][**Aluminum, fluoropolymer-coated finish, of color and gloss selected by Architect from manufacturer's full range**].

G. APP-Modified-Bitumen, Smooth-Surfaced Flashing Sheet: [**ASTM D6222/D6222M, Type I or II, Grade S, polyester-reinforced**][**ASTM D6223/D6223M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers**], smooth surfaced, suitable for application method specified.

H. APP-Modified-Bitumen, Granule-Surfaced Flashing Sheet: [**ASTM D6222/D6222M, Type I or II, Grade G, polyester-reinforced**][**ASTM D6223/D6223M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers**], granule-surfaced, suitable for application method specified, and as follows:

1. Granule Color: [**White**][**Gray**][**Tan**].

I. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D1668/D1668M, Type I.

J. Liquid Flashing System: Roof membrane manufacturer's standard one- or two-part moisture curing resin with low solvent content, consisting of a primer, flashing cement, and scrim.

2.6 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D41/D41M.

B. Roofing Asphalt: ASTM D312/D312M, [**Type III**][**Type IV**][**Type III or IV as recommended by roofing system manufacturer for application**], suitable for installation method specified.

C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M, suitable for installation method specified.

2.7 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing system components, and suitable for installation method specified.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

B. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

C. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

D. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft. (0.16 kg/sq. m)**.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.

G. Cold-Applied Asphalt Adhesive: ASTM D4479/D4479M, Type I or Type II, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.

H. Cold-Applied Polymer-Modified Asphalt Adhesive: Roof membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system, base flashings, and aggregate surfacing adhesive.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing manufacturer for application.

J. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.

L. Aggregate Surfacing: ASTM D1863/D1863M, No. 6 or No. 67, clean, dry, opaque, [**water-worn gravel or crushed stone, free of sharp edges**][**crushed slag, free of sharp edges**].

M. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

2.8 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].
3. Surface Finish: [**Factory primed**][**Unprimed**].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

C. High-Density Polyisocyanurate Roof Substrate Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.9 VAPOR RETARDER

A. Rubberized Asphalt Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum **40-mil (1.0-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

B. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum **30-mil (0.76-mm)** total thickness; maximum permeance rating of **0.1 perm (6 ng/Pa x s x sq. m)**; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers, fire-retardant polyethylene laminate, reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
3. Flame Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

D. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt impregnated.

2.10 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured[**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density, 25 psi (173 kPa) minimum compressive strength**][**Type V, 3.0-lb/cu. ft. (48-kg/cu. m) minimum density, 100 psi (690 kPa) minimum compressive strength**], square edged.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DuPont de Nemours, Inc.**]
b. [**Kingspan Insulation LLC**]
c. [**Owens Corning**]
d. [**Soprema, Inc.**]

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.

3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

    a. Base Layer: [1-1/2 inches (38 mm)]

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578 Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) minimum density, 13 psi (90 kPa) minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Molded Products, a division of Atlas Roofing Corporation**]
    b. [**Carlisle Syntec Systems**]
    c. [**Cellofoam North America, Inc.**]
    d. [**Kingspan Insulation LLC**]

2. Thermal Resistance: R-value of 3.8 per 1 inch (25 mm).
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

    a. Base Layer: [1-1/2 inches (38 mm)]

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II, 1.35-lb/cu. ft. (22-kg/cu. m)**][**Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m)**][**Type IX, 1.8-lb/cu. ft. (29-kg/cu. m)**] minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cellofoam North America, Inc.**]
    b. [**Insulfoam; a Carlisle Company**]

2. Facer: [**ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick**][**DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick**].
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Atlas Polyiso Roof and Wall Insulation**]
    b. [**Carlisle Syntec Systems**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Elevate; Holcim Building Envelope**]
    e. [**GAF**]
    f. [**Hunter Panels; a Carlisle company**]

g. [**IKO Industries Inc.**]
h. [**Insulfoam; a Carlisle Company**]
i. [**Johns Manville; a Berkshire Hathaway company**]
j. [**Kingspan Insulation LLC**]
k. [**Polyglass U.S.A., Inc.**]
l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**]
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Polyiso Roof and Wall Insulation**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Elevate; Holcim Building Envelope**]
d. [**GAF**]
e. [**Hunter Panels; a Carlisle company**]
f. [**Insulfoam; a Carlisle Company**]
g. [**Johns Manville; a Berkshire Hathaway company**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, oriented strand board facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

G. Perlite Board Insulation: ASTM C728, Type I, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GAF**]
b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**]
4. Thickness:

a. Base Layer: [**1-1/2 inches (38 mm)**].

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blue Ridge Fiberboard**]
   b. [**GAF**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Homasote Company**]
   e. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per **1 inch (25 mm)**.
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1 inch (25 mm)**][**2 inches (51 mm)**].

I. Cellular-Glass Board Insulation: ASTM C552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Pittsburgh Corning Corporation**]

2. Thermal Resistance: R-value of 3.44 per **1 inch (25 mm)**.
3. Size: **24 by 48 inches (600 by 1200 mm)**.

J. Mineral Wool Board Insulation - Multidensity: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with an **11.2-lb/cu. ft. (180-kg/cu. m)** density and a lower layer with a **7.5-lb/cu. ft. (120-kg/cu. m)** density.

1. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness:

   a. Base Layer: [**2 inches (51 mm)**].

4. Face Treatment: Bitumen coating.

K. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having a **12.5-lb/cu. ft. (200-kg/cu. m)** density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.
4. Face Treatment: Bitumen coating.

L. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

   a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
   b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

M. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use and compatible with other roofing system components.

N. Insulation Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing membrane manufacturer.

O. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread spray-applied, low-rise, two-component urethane adhesive.
4. Verify adhesives and sealants comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesives: 80 g/L.
   f. PVC Welding Compounds: 510 g/L.
   g. Other Adhesives: 250 g/L.
   h. Single-Ply Roof Membrane Sealants: 450 g/L.
   i. Nonmembrane Roof Sealants: 300 g/L.
   j. Sealant Primers for Nonporous Substrates: 250 g/L.
   k. Sealant Primers for Porous Substrates: 775 g/L.

5. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Verify adhesives and sealants comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

P. Insulation Cant Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board**].

Q. Wood Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."

R. Tapered Edge Strips: [**ASTM C728, perlite insulation board**][**ASTM C208, Type II, Grade 1,**

cellulosic-fiber insulation board].

2.11 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use; compatible with other roofing system components and suitable for installation method specified.

B. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with non-asphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

I. Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1/2 inch (13 mm)** thick, having a minimum compressive strength of **80 psi (551 kPa)**.

2.12 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.13 ROOF COATING SYSTEM

A. Primer: Roof coating manufacturer's standard primer to enhance the adhesion of roof coating to substrate.

B. Asphalt Emulsion Coating, Asbestos Free: ASTM D1227/D1227M, Type II, [**Class 1, mineral-colloid-emulsified, fibered**][**Class 2, chemically emulsified, filled or fibered**].

C. Asphalt Emulsion Coating, Nonfibered: ASTM D1227/D1227M, Type III, [**Class 1, mineral-colloid-emulsified**][**Class 2, chemically emulsified**].

D. Aluminum-Pigmented Asphaltic Coating: ASTM D2824/D2824M, [**Type I, nonfibered**][**Type III, fibered, asbestos-free**].

E. Acrylic Elastomer Emulsion Coating: ASTM D6083/D6083M, formulated for use on bituminous roof surfaces.

F. Silicone Coating: ASTM D6694/D6694M, formulated for use on bituminous roof surfaces.

G. Color: [**White**][**Highly reflective white**][**Gray**][**Tan**].

2.14 WALKWAYS

A. Walkway Pads: [**Reinforced asphaltic composition pads with slip-resisting mineral-granule surface**][**Polymer-modified, reconstituted rubber pads with slip-resisting textured surface**], manufactured as a traffic pad for foot traffic and acceptable to roofing membrane manufacturer.

1. Pad Size: Approximately [**36 by 60 inches (914 mm by 1524 mm)**][**30 by 30 inches (762 mm by 762mm)**].
2. Color: [**Contrasting with cap sheet**][**Gray**][**Yellow**][**White**].

B. Walkway Cap Sheet Strips: Matching cap sheet; suitable for installation method specified, and as follows:

1. Size: [36 by 60 inches (914 mm by 1524 mm)].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.

    a. Test Frequency: One test probe per each [1000 sq. ft. (93 sq. m)], or portion thereof, of roof deck, with not less than three test probes.
    b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify that adjacent cementitious wood fiber panels are vertically aligned to within 1/8-inch (3 mm) at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing manufacturer's written installation instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of **3/4 gal./100 sq. ft. (0.3 L/sq. m)**, and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roof system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind-uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof decks in accordance with roof deck manufacturer's written installation instructions.

3.3 INSTALLATION OF BUILT-UP ASPHALT ROOFING SYSTEM, GENERAL

A. Install roofing system in accordance with manufacturer's written instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Asphalt Heating:

1. Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before application.
2. Circulate asphalt during heating.

a. Do not raise asphalt temperature above equiviscous temperature range more than one hour before time of application.

3. Do not exceed asphalt manufacturer's recommended temperature limits during asphalt heating.
4. Do not heat asphalt within **25 deg F (14 deg C)** of flash point.
5. Discard asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.

a. Apply hot roofing asphalt within plus or minus **25 deg F (14 deg C)** of equiviscous temperature.

F. SEBS-Modified Asphalt Heating: Heat and apply roofing asphalt in accordance with roofing manufacturer's written instructions.

G. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints,

entering building, or damaging roofing components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with recommendations in [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
2. Continuously seal side and end laps.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.

6. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

D. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:

1. [16 feet (4.88 m)] apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
2. [48 inches (1200 mm)] apart for roof slopes greater than 3 inches per 12 inches (3:12).

E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane with vertical surfaces or angle changes greater than 45 degrees.

3.7 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
3. Trim cover board so that water flow is unrestricted.
4. Cut and fit cover board tight to nailers, projections, and penetrations.
5. Adhere cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install sheathing paper over cover board and immediately beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF BUILT-UP ROOFING MEMBRANE

A. Install roofing membrane in accordance with roofing system manufacturer's written installation instructions and applicable recommendations of NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:

1. Base Sheet: [**One**][**One, installed over sheathing paper**].
2. Number of Ply Sheets: [**Two**][**Three**][**Four**].
3. Surfacing: [**Aggregate**][**Asphalt surfacing or coating**][**Mineral-granule-surfaced cap sheet**].
4. Mineral-granule-surfaced cap sheet is in addition to number of ply sheets specified.

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

C. Where roof slope exceeds [**1/2 inch per 12 inches (1:24)**][**3/4 inch per 12 inches (1:18)**], install roofing ply sheets parallel with slope.

1. Backnail roofing ply sheets to [**nailer strips**][**substrate**] in accordance with roofing system manufacturer's written instructions.

D. Coordinate installation of roofing, so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

E. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of **2 inches (51 mm)** and **6 inches (150 mm)**, respectively.

F. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:

1. Mechanically fasten to substrate.
2. Spot or strip mop to substrate with hot roofing asphalt.
3. Adhere to substrate [**in a solid mopping of hot roofing asphalt**][**using cold-applied asphalt adhesive**][**using cold-applied polymer-modified asphalt adhesive**].

G. Install [**three**][**four**] ply sheets, starting at low point of roof.

1. Align ply sheets without stretching.
2. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane.

    a. Shingle in direction to shed water.

3. Extend ply sheets over and terminate above cants.
4. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
5. Embed each ply sheet in cold-applied asphalt adhesive applied at a rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
6. Embed each ply in cold-applied polymer-modified asphalt adhesive applied at a rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
7. Install ply sheets without wrinkles, tears, and free from air pockets.

H. Cap Sheet: Install lapped granulated cap sheet, starting at low point of roofing.

1. Offset laps from laps of preceding ply sheets, and align cap sheet without stretching.
2. Lap in direction to shed water.
3. Extend cap sheet over and terminate above cants.
4. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing system manufacturer.
5. Embed each ply sheet in cold-applied asphalt adhesive applied at a rate required by roofing

system manufacturer.

6. Embed each ply in cold-applied polymer-modified asphalt adhesive applied at a rate required by roofing system manufacturer.
7. Install cap sheet without wrinkles, tears, and free from air pockets.

I. Aggregate Surfacing: After installing and testing roofing, base flashing, and stripping, promptly apply flood coat to roof surface with [**60 lb/100 sq. ft. (3.0 kg/sq. m) of hot roofing asphalt**][**cold-applied polymer-modified asphalt adhesive at rate recommended by roof system manufacturer**]. [**While flood coat is hot and fluid, cast**][**Cast**] the following average weight of aggregate in a uniform course:

1. Aggregate Weight: [**400 lb/100 sq. ft. (20 kg/sq. m)**][**300 lb/100 sq. ft. (15 kg/sq. m)**].
2. If aggregate surfacing is delayed, promptly apply glaze coat of [**hot roofing asphalt at a rate of 10 lb/100 sq. ft. (0.5 kg/sq. m)**][**cold-applied polymer-modified asphalt adhesive at a rate recommended by roof system manufacturer**].

J. Glaze-coat roofing surface with hot roofing asphalt applied at a rate of **10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m)**.

3.10 INSTALLATION OF FLASHING AND STRIPPING

A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates in accordance with roofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Application: [**Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants**][**Adhere backer sheet to substrate**] in [**a solid mopping of hot roofing asphalt**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**].
3. Flashing Sheet Application, Hot: [**Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer**][**Torch-apply flashing sheet to substrate**].
4. Flashing Sheet Application, Cold: Adhere flashing sheet to substrate in [**cold-applied adhesive**][**cold-applied polymer-modified adhesive**][**asphalt roofing cement**] at rate required by roofing manufacturer.

B. Extend base flashing up walls or parapets a minimum of **8 inches (200 mm)** above built-up roofing and **4 inches (100 mm)** onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing[**with a strip of glass-fiber fabric set in asphalt roofing cement**].

D. Install liquid flashing system in accordance with manufacturer's recommendations.

1. Extend liquid flashing not less than **3 inches (76 mm)** in all directions from edges of item being flashed.
2. Embed granules, matching color of roof membrane, into wet compound.

E. Install stripping in accordance with roofing system manufacturer's written instructions, where metal flanges and edgings are set on roofing membrane.

1. Install flashing sheet stripping in a continuous coating of asphalt roofing cement, in [**a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C), and extend onto roofing membrane**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**].
2. Install flashing sheet stripping by heat welding and extend onto roofing membrane.
3. Install stripping of not fewer than two roofing ply sheets, setting each ply in a continuous coating of asphalt roofing cement, in [**a solid mopping of hot roofing asphalt**][**cold-applied adhesive**][**cold-applied polymer-modified adhesive**], and extend onto roofing membrane **4 inches (100 mm)** and **6 inches (150 mm)**, respectively.

F. Roof Drains: Set [**30-by-30-inch (760-by-760-mm)**] **4-pound (1.8-kg)** lead flashing in bed of asphaltic adhesive on completed roofing membrane.

1. Cover metal flashing with roofing cap sheet stripping, and extend a minimum of [**4 inches (100 mm)**][**6 inches (150 mm)**] beyond edge of metal flashing onto field of roofing membrane.
2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping in accordance with roofing manufacturer's written instructions.

3.11 INSTALLATION OF ROOF COATING SYSTEM

A. Apply coating to [**roofing membrane**][**base flashings**] in accordance with manufacturer's written instructions, by spray, roller, or other suitable application method[**, to provide a dry film thickness of not less than 20 mils (0.5 mm)**].

3.12 INSTALLATION OF WALKWAYS

A. Walkway Pads: Install walkway pads, using units of size indicated or, if not indicated, of manufacturer's standard size, in accordance with walkway pad manufacturer's written instructions.

1. Install walkways at following locations:

    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    d. Top and bottom of each roof access ladder.
    e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    f. Locations indicated on Drawings.
    g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining pads.
3. Set walkway pads [**in additional pour coat of hot roofing asphalt**][**in cold-applied adhesive**][**in cold-applied polymer-modified adhesive**] after sweeping away loose aggregate surfacing.

B. Walkway Cap-Sheet Strips: Install walkway cap-sheet strips, approximately **36 inches (914 mm)** wide and in lengths not exceeding **10 feet (3 m)**, over roofing membrane, using same application method as used for roofing cap sheet.[**Install walkway cap-sheet strips before flood coat and aggregate surface is applied.**]

1. Install walkways strips at following locations:

    a. Perimeter of each rooftop unit.

b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjoining strips.

C. Roof-Paver Walkways: Install walkway roof pavers in accordance with roofing manufacturer's written instructions.

1. Install roof paver walkways at following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide **3-inch (76-mm)** clearance between adjacent roof pavers.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roofing area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

a. Perform tests before overlying construction is placed.
b. Flood to an average depth of [**2-1/2 inches (65 mm)**] with a minimum depth of [**1 inch (25**

mm)] and not exceeding a depth of [4 inches (100 mm)]. Maintain 2 inches (51 mm) of clearance from top of base flashing.
c. Flood each area for [**24**][**48**][**72**] hours.
d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.

a. Perform tests before overlying construction is placed.
b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M.

a. Perform tests before overlying construction is placed.
b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with SPRI/RCI NT-1.

a. Perform tests before overlying construction is placed.
b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing system as follows:

1. Determine approximate quantities of components within roofing system in accordance with ASTM D3617/D3617M.
2. Examine test specimens for interply voids in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
3. Repair areas where test cuts were made in accordance with roofing manufacturer's written

instructions.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify the Owner 48 hours in advance of date and time of inspection.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

1. Roofing system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.14 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.15 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:
6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own

cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and will afford reasonable opportunity for Roofing System Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 65 16 00

SECTION 07 65 16 00A - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ethylene-propylene-diene-terpolymer (EPDM) roofing system.
2. Accessory roofing system materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation and accessories.
6. Cover board.
7. Electronic leak-detection (ELD) materials.
8. Ballast.
9. Walkways.

B. Section contains the installation of sound-absorbing insulation strips in ribs of acoustical steel roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 053100 "Steel Decking" for roof deck panels[**and sound-absorbing insulation strips**].
2. Section 061000 "Rough Carpentry for wood nailers, curbs, and blocking[**and for wood-based, structural-use roof deck panels**].
3. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 077100 "Roof Specialties" for [**premanufactured copings**][**roof edge fasciae**][**gravel stops**][**reglets**][**roof edge flashings**][**counterflashings**].
6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
7. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
8. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
9. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner’s insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work

interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**].

1. Meet with the Owner, Architect,[**Construction Manager,**] the Owner’s insurer if applicable, testing and inspecting agency representative, roofing system Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, roofing system Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base and sheet flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastening spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Crickets, saddles, and tapered edge strips, including slopes.
8. Tie-in with adjoining wall system air barrier.

C. Samples for Verification: For the following products:

1. Roofing membrane and flashings of color required.
2. Aggregate surfacing material in gradation[**and color**] required.

3. Roof paver[**full sized,**] in each color and texture required.
4. Walkways, of color required.

D. Wind-Uplift-Resistance Submittal: For roofing system, indicating compliance with wind-uplift performance requirements.

E. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of complying with specified performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, tests performed by an independent qualified testing agency, indicating compliance with specified requirements.

C. Research Reports: For components of roofing system, from [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**] showing compliance with specified performance requirements.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality control reports.

F. Qualification Statements: For roofing system [**Installer**][**manufacturer**][**testing agency**].

G. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

B. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not

been affected by the Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is [**UL listed**][**listed in FM Approvals' RoofNav**][**listed in SPRI's "Directory of Roof Assemblies"**] for roofing system identical to that used for this Project.

B. Roofing System Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Certified Roofing System Installer: Entity that employs [**a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified EPDM system installers**][**a supervisor who is an NRCA ProCertified Roofing Foreman**][**a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified EPDM system installers**].

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membrane, base flashing sheet, [**ballast,**][**walkways,**] and other components of roofing system.
2. Warranty Period: [**10**][**15**][**20**][**30**] years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit roofing system Installer's warranty, on warranty form at end of this Section, signed by roofing system Installer, covering the Work of this Section, including all components of roofing system, such as [**substrate board,**][**vapor retarder,**] roof insulation, fasteners, adhesives,[**cover board,**] roofing membrane, base flashing sheet, [**ballast,**][**walkways,**] and other components of roofing system.

1. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain components for roofing system from [**roofing membrane manufacturer**][**manufacturer approved by roofing membrane manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and base flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897.

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [**Class 1A-60**][**Class 1A-75**][**Class 1A-90**][**Class 1A-105**][**Class 1A-120**].
2. Hail-Resistance Rating: FM 1-34 [**MH**][**SH**][**VSH**].

E. SPRI's "Directory of Roof Assemblies" Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's "Directory of Roof Assemblies" for roof assembly identical for that specified for this Project.

1. Wind-Uplift Load Capacity: [**60 psf**][**75 psf**][**90 psf**][**105 psf**][**120 psf**].

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**25**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Not less than [**78**][**29**] when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

I. Cool Roof Rating Council (CRRC): Roofing system to be listed by the CRRC for low-slope roof products.

J. Energy Performance: Roofing system to have an initial solar reflectance index (SRI) of not less than [**0.70**] and an emissivity of not less than [**0.75**] when tested in accordance with CRRC S100.

K. Exterior Fire-Test Exposure: [**Class A**][**Class B**][**Class C**]; for application and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

L. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.3 ETHYLENE-PROPYLENE-DIENE-TERPOLYMER (EPDM) ROOFING SYSTEM

A. EPDM Roofing Membrane Sheet: ASTM D4637/D4637M, [**Type I, nonreinforced,**][**Type II, scrim or fabric internally reinforced,**][**self-adhering**] EPDM sheet[**with factory-applied seam tape**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Carlisle Syntec Systems**]
   b. [**Elevate; Holcim Building Envelope**]
   c. [**GenFlex Roofing Systems**]
   d. [**Johns Manville; a Berkshire Hathaway company**]
   e. [**Lexcan, division of Lexsuco Corporation**]
   f. [**Mule-Hide Products Co., Inc**]
   g. [**Roofing Products International, Inc**]
   h. [**Versico Roofing Systems; Carlisle Construction Materials**]

2. Thickness: [**45 mils (1.1 mm)**][**60 mils (1.5 mm)**][**75 mils (1.9 mm)**][**90 mils (2.2 mm)**], nominal.
3. Exposed Face Color: [**Black**][**White on black**].

B. Fabric-Backed EPDM Roofing Membrane Sheet: ASTM D4637/D4637M, Type III, nonreinforced, EPDM sheet, laminated to a nonwoven polyester fabric backing except at selvages[**with factory-applied seam tape**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Syntec Systems**]
    b. [**Versico Roofing Systems; Carlisle Construction Materials**]

2. Composite Thickness: [**90 mils (2.3 mm)**][**100 mils (2.5 mm)**][**105 mils (2.7 mm)**][**115 mils (2.9 mm)**], nominal.
3. Exposed Face Color: [**Black**][**White on black**].

2.4 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

B. Base and Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as roofing membrane.

C. Protection Sheet: As recommended in writing by roofing membrane manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.

D. Slip Sheet: [**ASTM D2178/D2178M, Type IV; glass fiber; asphalt-impregnated felt**][**Manufacturer's standard, of thickness required for application**].

E. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt impregnated, fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.

F. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

G. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than **4-inch (100-mm)** diameter.

H. Bonding Adhesive: Roofing membrane manufacturer's standard[**water based**].

I. Modified Asphaltic Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard modified asphalt, asbestos-free, cold-applied adhesive formulated for compatibility and use with fabric-

backed membrane roofing.

J. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.

K. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.

L. Seaming Material: [**Single-component, butyl splicing adhesive and splice cleaner**][**Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film**][**Factory-applied seam tape, width as recommended by manufacturer**].

M. Lap Sealant: Manufacturer's standard, single-component sealant[**colored to match membrane roofing**].

N. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

O. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.

P. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately **1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick)**, prepunched.

Q. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing system components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

R. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.

S. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

T. Liquid Roof Coating: Product specifically formulated for coating roofing membrane, as follows:

1. Type: [**Acrylic emulsion complying with ASTM D6083/D6083M**][**Chlorosulfonated polyethylene complying with ASTM D3468/D3468M**].
2. Color: [**White**][**Gray**][**Tan**][**As selected by Architect from manufacturer's full range**].

2.5 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [1/4 inch (6 mm)][1/2 inch (13 mm)][Type X, 5/8 inch (16 mm)].
3. Surface Finish: [Factory primed][Unprimed].

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [1/4 inch (6 mm)][3/8 inch (10 mm)][1/2 inch (13 mm)][5/8 inch (16 mm)].

C. High-Density Polyisocyanurate Cover Board: ASTM C1289, Type II, Class 4, Grade 1, 1/2 inch (13 mm) thick, having a minimum compressive strength of 80 psi (551 kPa).

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

E. Bonding Adhesive: Manufacturer's standard, designed for adhering substrate board to roof deck.

2.6 VAPOR RETARDER

A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil (1.0-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil (0.76-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

C. Laminated Sheet Vapor Retarder: Two layers; fire-retardant polyethylene laminate; reinforced with cord grid.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Reef Industries, Inc.**]

2. Permeance Rating: Not more than 0.062 perm (3.556 ng/Pa x s x sq. m) when tested in accordance with ASTM E96/E96M.
3. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
4. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
5. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.7 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured[**or approved**] by roofing membrane manufacturer, approved for use in [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.45 lb/cu. ft. (23 kg/cu. m) minimum**

density, 25 psi (173 kPa) minimum compressive strength][Type V, 3.00 lb/cu. ft. (48 kg/cu. m), minimum density, 100 psi (690 kPa) minimum compressive strength] square edged.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

    a. **[DuPont]**
    b. **[Kingspan Insulation LLC]**
    c. **[Owens Corning]**
    d. **[Soprema, Inc.]**

2. Thermal Resistance: R-value of 5.0 per **1 inch (25 mm)**.
3. Size: **[48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)]**.
4. Thickness:

    a. Base Layer: **[1-1/2 inches (38 mm)]**

C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, **1.15 lb/cu. ft. (18 kg/cu. m)** minimum density, **13 psi (90 kPa)** minimum compressive strength, square edge.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

    a. **[Atlas Molded Products, a division of Atlas Roofing Corporation]**
    b. **[Carlisle Syntec Systems]**
    c. **[Cellofoam North America, Inc.]**
    d. **[Kingspan Insulation LLC]**

2. Thermal Resistance: R-value of 3.8 per **1 inch (25 mm)**.
3. Size: **[48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)]**.
4. Thickness:

    a. Base Layer: **[1-1/2 inches (38 mm)]**

D. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, **[Type II, 1.35 lb/cu. ft. (22 kg/cu. m)][Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m)][Type IX, 1.8 lb/cu. ft. (29 kg/cu. m)]** minimum density, with factory-applied facings, as follows:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

    a. **[Carlisle Syntec Systems]**
    b. **[Cellofoam North America, Inc.]**
    c. **[Insulfoam; a Carlisle Company]**

2. Facer: **[ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated,**

1/2 inch (13 mm) thick][**DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick**].

3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].

E. Polyisocyanurate Board Insulation: ASTM C1289, Type II, [**Class 1 felt facer**][**Class 2 coated glass-fiber facer**][**Class 3 uncoated glass-fiber facer**] on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Elevate; Holcim Building Envelope**]
   e. [**GAF**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**IKO Industries Inc.**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Kingspan Insulation LLC**]
   k. [**Polyglass U.S.A., Inc.**]
   l. [**Rmax, A Business Unit of Sika Corporation**]

2. Compressive Strength: [**Grade 2, 20 psi (138 kPa)**][**Grade 3, 25 psi (172 kPa)**].
3. Size: [**48 by 48 inches (1200 by 1200 mm)**][**48 by 96 inches (1200 by 2400 mm)**].
4. Thickness:

   a. Base Layer: [**1-1/2 inches (38 mm)**].

F. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atlas Polyiso Roof and Wall Insulation**]
   b. [**Carlisle Syntec Systems**]
   c. [**CertainTeed; SAINT-GOBAIN**]
   d. [**Elevate; Holcim Building Envelope**]
   e. [**GAF**]
   f. [**Hunter Panels; a Carlisle company**]
   g. [**IKO Industries Inc.**]
   h. [**Insulfoam; a Carlisle Company**]
   i. [**Johns Manville; a Berkshire Hathaway company**]
   j. [**Kingspan Insulation LLC**]
   k. [**Polyglass U.S.A., Inc.**]
   l. [**Rmax, A Business Unit of Sika Corporation**]

2. Facer: [**Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick**][**Type V, OSB facer, 7/16 inch (11 mm) thick**][**Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick**].

3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].

G. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GAF**]
b. [**Johns Manville; a Berkshire Hathaway company**]

2. Thermal Resistance: R-value of 2.78 per 1 inch (25 mm).
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

a. Base Layer: [1-1/2 inches (38 mm)].

H. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood-fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Ridge Fiberboard**]
b. [**GAF**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Homasote Company**]
e. [**Huebert Fiberboard Inc**]

2. Thermal Resistance: R-value of 2.78 per 1 inch (25 mm).
3. Size: [48 by 48 inches (1200 by 1200 mm)][48 by 96 inches (1200 by 2400 mm)].
4. Thickness:

a. Base Layer: [1 inch (25 mm)][2 inches (50 mm)].

I. Mineral Wool Board Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of 11.2 lb/cu. ft. (180 kg/cu. m) density, and a lower layer of 7.5 lb/cu. ft. (120 kg/cu. m) density.

1. Thermal Resistance: R-value of 3.8 per 1 inch (25 mm).
2. Size: 48 by 48 inches (1200 by 1200 mm).
3. Thickness:

a. Base Layer: [2 inches (50 mm)].

J. Mineral Wool Board Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having 12.5 lb/cu. ft. (200 kg/cu. m) density.

1. Thermal Resistance: R-value of 4.0 per **1 inch (25 mm)**.
2. Size: **48 by 48 inches (1200 by 1200 mm)**.
3. Thickness: **1 inch (25 mm)**.

K. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: [**Match roof insulation**].
2. Minimum Thickness: **1/4 inch (6 mm)**.
3. Slope:

   a. Roof Field: [**1/4 inch per foot (1:48)**] unless otherwise indicated on Drawings.
   b. Saddles and Crickets: [**1/2 inch per foot (1:24)**] unless otherwise indicated on Drawings.

L. General: Roof insulation accessories as recommended in writing by insulation manufacturer for intended use and compatibility with other roofing system components.

1. Insulation Adhesive: Insulation manufacturer's standard adhesive formulated to attach roof insulation [**to substrate**] to another insulation layer as follows:

   a. Modified asphaltic, asbestos-free, cold-applied adhesive.
   b. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
   c. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

2. Verify adhesives and sealants comply with the following limits for VOC content:

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesives: 80 g/L.
   f. PVC Welding Compounds: 510 g/L.
   g. Other Adhesives: 250 g/L.
   h. Single-Ply Roof Membrane Sealants: 450 g/L.
   i. Nonmembrane Roof Sealants: 300 g/L.
   j. Sealant Primers for Nonporous Substrates: 250 g/L.
   k. Sealant Primers for Porous Substrates: 775 g/L.

3. Insulation Fasteners: Insulation manufacturer's standard factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation[**and cover board**] to substrate, and acceptable to roofing system manufacturer.

2.8 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

B. Cellulosic-Fiber Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of **40 psi (276 kPa)**.

1. Thickness: [**1/2 inch (13 mm)**][**1 inch (25 mm)**].
2. Surface Finish: [**Primed one side**][**Primed two sides with nonasphaltic primer**][**Integral coating, six sides**][**Unprimed**].

C. Oriented Strand Board: DOC PS 2, Exposure 1, **7/16 inch (11 mm)** thick.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum substrate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**USG Corporation**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Factory primed**][**Unprimed**].

E. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

F. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

1. Thickness: [**7/16 inch (11 mm)**][**1/2 inch (13 mm)**][**5/8 inch (16 mm)**].

G. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Continuus Materials, LLC**]

2. Thickness: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**].
3. Surface Finish: [**Fiberglass facer**][**Paper facer**].

H. High-Density Polyisocyanurate Cover Board: ASTM C1289 Type II, Class 4, Grade 1, **1 inch (25 mm)** thick, with a minimum compressive strength of **80 psi (551 kPa)**.

I. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended in writing by roofing system manufacturer for application.

2.9 ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Conductive Medium: Electrically conductive material specifically designed to enable ELD testing procedures as approved in writing by roofing membrane manufacturer.

1. Conductive medium to be located directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Moisture-Monitoring System: Permanently embedded, continuously monitored moisture-detection system.

1. Sensors measuring moisture content to be placed within roofing system and connected to a monitoring program, with a notification indicating location of breach.

2.10 BALLAST

A. Aggregate Ballast: [**Smooth, washed, riverbed gravel or other acceptable smooth-faced stone**][**Crushed gravel or crushed stone**] that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:

1. Size: ASTM D448, [**Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm)**][**Size 3, ranging in size from 1 to 2 inches (25 to 50 mm)**][**Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm)**].

B. Interlocking Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hanover Architectural Products**]
b. [**Roofblok Limited**]
c. [**Westile Roofing Products; an Oldcastle company**]

2. Compressive Strength: [**2500 psi (17 MPa)**][**5000 psi (34 MPa)**], minimum.
3. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Rubber Roof Pavers: Interlocking, lightweight rubber units, **24 by 24 by 2-1/4 inches (600 by 600 by 57 mm)**, **6 lb/sq. ft. (30 kg/sq. m)**; with grooved back for four-way drainage, beveled and doweled; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Carlisle Syntec Systems**]

2. Perimeter Securement Strip: Manufacturer's standard [**coated steel sheet channel**][**aluminum sheet channel**][**mill-finish aluminum sheet hold-down**][**coated aluminum sheet hold-down, color as selected by Architect,**] and fasteners.
3. Color: [**Black**][**Gray**][**Terra cotta**].

D. Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Carlisle Coatings & Waterproofing Inc**]
    b. [**Hanover Architectural Products**]
    c. [**Roofblok Limited**]
    d. [**Sunny Brook Pressed Concrete, Co.**]
    e. [**Tile Tech Pavers**]
    f. [**Wausau Tile, Inc.**]
    g. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

1. Fasteners: **1-1/2-inch (38-mm)** stainless steel fasteners with neoprene washers.

2.11 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway [**pads**][**rolls**], approximately **3/16 inch (5 mm)** thick and acceptable to roofing system manufacturer.

1. Size: Approximately **36 by 60 inches (900 by 1500 mm)**.
2. Color: Contrasting with roof membrane.

B. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, [**square edged**][**with top edges beveled 3/16 inch (5 mm)**], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67/C67M; and as follows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hanover Architectural Products**]
    b. [**Roofblok Limited**]
    c. [**Sunny Brook Pressed Concrete, Co.**]
    d. [**Wausau Tile, Inc.**]
    e. [**Westile Roofing Products; an Oldcastle company**]

2. Size: [**24 by 24 inches (600 by 600 mm)**]. Manufacture pavers to dimensional tolerances of plus or minus **1/16 inch (1.6 mm)** in length, height, and thickness.
3. Compressive Strength: [**7500 psi (52 MPa)**][**6500 psi (45 MPa)**], minimum.
4. Colors and Textures: [**As indicated by manufacturer's designations**][**Match Architect's**

samples][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with roofing system Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of **1/16 inch (1.6 mm)** out of plane relative to adjoining deck.
5. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [**75**] percent, or as recommended by roofing system manufacturer when tested in accordance with ASTM F2170.

    a. Test Frequency: One test probe per each [**1000 sq. ft. (93 sq. m)**], or portion thereof, of roof deck, with not less than three test probes.
    b. Submit test reports within 24 hours of performing tests.

7. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
9. Verify that minimum curing period recommended by roof system manufacturer for lightweight insulating concrete roof decks has passed.
10. Verify any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
11. Verify adjacent cementitious wood-fiber panels are vertically aligned to within **1/8 inch (3 mm)** at top surface.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with primer in accordance with roofing system manufacturer's written installation instructions and allow primer to dry.

D. Perform fastener-pullout tests in accordance with roofing system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

    a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

E. Install sound-absorbing insulation strips in ribs of acoustical steel roof deck in accordance with roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, [**FM Approvals' RoofNav**][**SPRI's "Directory of Roof Assemblies"**] assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition[**and to not void warranty for existing roofing system**].

D. Coordinate installation and transition of roofing system component serving as an air barrier with wall system air barrier specified under [**Section 072713 "Modified Bituminous Sheet Air Barriers."**][**Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."**][**Section 072726 "Fluid-Applied Membrane Air Barriers."**]

E. Substrate-Joint Penetrations: Prevent adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (600 mm)** in adjacent rows.

1. Install substrate board at right angle to flutes of steel roof deck. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck in accordance with manufacturer's written installation instructions and [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift load capacity**] and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written installation instructions.
6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF VAPOR RETARDER

A. Install vapor retarder in a single layer over roof area in accordance with manufacturer's written installation instructions, side and end lapping each sheet a minimum of **2 and 6 inches (50 and 150 mm)**, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with tape.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with [**joints staggered not less than 24 inches (600 mm) in adjacent rows**][**end joints staggered not less than 12 inches (300 mm) in adjacent rows**] and offset not less than **12 inches (300 mm)** from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus **24 inches (600 mm)**.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
6. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
7. Secure insulation in accordance with [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" for specified wind-uplift load capacity**].
8. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
9. Loosely lay each layer of insulation over substrate.

3.7 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

    a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate in accordance with [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**][**SPRI's "Directory of Roof Assemblies" listed roof assembly requirements for specified wind-uplift**

load capacity] and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install slip sheet over cover board and beneath roofing membrane.

3.8 INSTALLATION OF ELECTRONIC LEAK-DETECTION (ELD) MATERIALS

A. Install conductive medium directly under roofing membrane in accordance with ASTM D7877 and ASTM D8231.

B. Install sensors, connections, and accessory items required for complete continuously monitored moisture-detection system in accordance with manufacturer's written installation instructions.

3.9 INSTALLATION OF EPDM ROOFING MEMBRANE

A. Install roofing membrane over roof area for [**adhered**][**self-adhered**][**mechanically attached**][**loose-laid, ballasted**] application method in accordance with roofing system manufacturer's written installation instructions.

B. Unroll roofing membrane and allow it to relax before installing.

C. Start installation in presence of roofing system manufacturer's technical personnel[**and the Owner's testing and inspection agency**].

D. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

E. Adhered Application: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply to splice area of roofing membrane.

1. In addition to adhering, mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roof area.

F. Mechanically Attached Application: Secure roofing membrane over area to receive roofing in accordance with roofing system manufacturer's written installation instructions.

1. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.

G. Loose-Laid, Ballasted Application: Comply with requirements in ANSI/SPRI RP-4 for [**System 1**][**System 2**][**System 3**].

1. [**Mechanically fasten**][**Adhere**] roofing membrane at perimeter, corners, and transitions in accordance with requirements in ANSI/SPRI RP-4.
2. At corners and perimeters, omit aggregate ballast leaving roofing membrane exposed.
3. At corners and perimeters, adhere a second layer of roofing membrane.
4. Install protection mat over roofing membrane, overlapping a minimum of **6 inches (150 mm)**. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of **12 inches (300 mm)**.
5. Aggregate Ballast: Apply uniformly over roofing membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of

damage to roofing system. Lay ballast as roof membrane is installed, leaving roof membrane ballasted at end of workday.

a. Ballast Weight:

1) Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**.
2) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**, at corners and perimeter; Size 4 aggregate, **10 lb/sq. ft. (50 kg/sq. m)**, elsewhere.
3) Size 2 aggregate, **13 lb/sq. ft. (65 kg/sq. m)**.

6. Roof-Paver Ballast: Install [**lightweight**][**heavyweight**] roof-paver ballast in accordance with manufacturer's written instructions.
7. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers in accordance with manufacturer's written instructions on roof corners and perimeter.

a. Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of **10 lb/sq. ft. (50 kg/sq. m)**.
b. Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of **13 lb/sq. ft. (65 kg/sq. m)**.

H. Adhesive Seam Installation: Clean both faces of splice areas and apply splicing cement.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.
3. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.

I. Tape Seam Installation: Clean and prime both faces of splice areas and apply splice tape.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.

J. Factory-Applied Seam Tape Installation: Clean and prime surface to receive tape.

1. Firmly roll side and end laps of overlapping roofing membrane to ensure a watertight seam installation.
2. Apply lap sealant and seal exposed edges of roofing terminations.

K. Repair tears, voids, and lapped seams in roofing membrane that do not comply with requirements.

L. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roofing membrane in place with clamping ring.

M. Adhere protection sheet over roofing membrane at locations indicated.

3.10 INSTALLATION OF BASE AND SHEET FLASHINGS

A. General: Install and adhere base and sheet flashings and preformed flashing accessories to substrates in accordance with roofing system manufacturer's written installation instructions.

B. Apply bonding adhesive to substrate and underside of flashings at required rate and allow to partially dry. Do not apply to seam area of flashings.

C. Flash penetrations and field-formed inside and outside corners.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping flashings to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of terminations.

E. Terminate and seal top of flashings and mechanically anchor to substrate through termination bars.

3.11 INSTALLATION OF LIQUID ROOF COATING

A. Apply coating to [**roof membrane**][**flashings**] in accordance with manufacturer's written recommendations, by spray, roller, or other suitable application method.

3.12 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products in accordance with manufacturer's written installation instructions.

1. Install flexible walkways at the following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.
   g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **6-inch (75-mm)** clearance between adjoining pads.
3. Adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers in accordance with manufacturer's written installation instructions.

1. Install roof-paver walkways at the following locations:

   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings.
   g. As required by roofing membrane manufacturer's warranty requirements.

2. Provide **3 inches (75 mm)** of space between adjacent roof pavers.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect, as directed by the Owner.

B. Tests and Inspections:

1. ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roofing membrane using ELD in accordance with ASTM D7877 and ASTM D8231.

   a. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

      1) Cost of retesting is Contractor's responsibility.

   b. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

2. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

   a. Flood to an average depth of [**2-1/2 inches (63 mm)**] with a minimum depth of [**1 inch (25 mm)**] and not exceeding a depth of [**4 inches (100 mm)**] of clearance from top of base flashing.
   b. Flood each area for [**24**][**48**][**72**] hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   d. Testing agency to prepare survey report indicating locations initial leaks, if any, and final survey report.

3. Infrared Thermography Testing: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153. Perform tests before overlying construction is placed.

   a. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
   b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

      1) Cost of retesting is Contractor's responsibility.

   c. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

4. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M. Perform tests before overlying construction is placed.

   a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

5. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ANSI/SPRI/RCI NT-1. Perform tests before overlying construction is placed.

a. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

b. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report, as directed by the Owner.

1. Notify Architect[**and the Owner**] 48 hours in advance of date and time of inspection, as directed by the Owner.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.14 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner, as directed by the Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.15 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. the Owner:
2. the Owner Address:
3. Building Name/Type:
4. Building Address:
5. Area of Work:

6. Warranty Period: [**Two**][**Five**] years from date of Substantial Completion.
7. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period, Roofing System Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if the Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If the Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. the Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and will afford reasonable opportunity for Roofing System Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract

directly with the Owner or a subcontract with the Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 65 16 00A

SECTION 07 65 16 00B - COATED FOAMED ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Spray-applied, coated, polyurethane foam roofing.

1. Polyurethane foam.
2. Urethane coatings.
3. Silicone coatings.
4. Acrylic coatings.
5. Substrate board.
6. Accessory materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking, curbs, cants, and nailers.
2. Section 072119 "Foamed-In-Place Insulation" for spray-applied polyurethane foam specified as general building insulation within walls and rafter spaces.
3. Section 076200 "Sheet Metal Flashing and Trim" for foam stops, roof penetration flashings, and counterflashings.
4. Section 079200 "Joint Sealants" for joint sealants, fillers, and preparation.

1.2 DEFINITIONS

A. Applicator: A qualified person employed to apply spray-applied, coated, polyurethane foam roofing.

B. Installer: A qualified firm contracted to install spray-applied, coated, polyurethane foam roofing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to coated foamed roofing, including, but not limited to, the following:

a. Load limitations on in-place roofing.
b. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Surface preparation specified in other Sections.
d. Minimum curing period.
e. Forecasted weather conditions.
f. Special details and sheet flashings.
g. Repairs.

1.4 ACTION SUBMITTALS

A. Product Data:[**Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties.**]

1. Polyurethane foam.
2. Urethane coatings.
3. Silicone coatings.
4. Acrylic coatings.
5. Substrate board.
6. Accessory materials.

B. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.

C. Samples for Initial Selection: For each type of exposed product, finish, and color.

1. Include Samples of accessory materials and accessories involving color and finish selection.

D. Samples for Verification: For coated foamed roofing, prepared on Samples of size indicated below:

1. Samples, **24 by 24 inches (600 by 600 mm)**, on rigid backing, showing polyurethane foam of thickness required and stepped coatings in colors required to illustrate buildup of coated foamed roofing.
2. Include Samples of accessories to verify color and finish selected.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For SPFA-qualified [**Installer**][**applicators**].

B. Product Certificates: For each type of coated foam roofing.

C. Evaluation Reports: For coated foamed roofing, from ICC-ES.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For coated foamed roofing to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified coated-foamed-roofing installer who is approved, authorized, or licensed by coating manufacturer for installation of coating manufacturer's product over polyurethane foam.

1. Engage an installer who participates in and who has fulfilled requirements of the SPFA program

for company accreditation as "SPFA PCP Accredited Company Roofing," with individual applicator certification for personnel assigned to work on Project.

B. Comply with recommendations in SPFA AY-104.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation, as directed by the Owner.

1. Build mockup of typical roof area as shown on Drawings.

a. Size: [**10 feet (3 m) by 10 feet (3 m)**]

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by manufacturer.

C. Remove and replace material that cannot be applied within its stated shelf life.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Apply materials within the range of ambient and substrate temperatures recommended in writing by material manufacturers, but not below **50 deg F (10 deg C)**.
2. Apply materials within range of relative humidity recommended in writing by manufacturer of each component, but not when relative humidity exceeds 85 percent, or when temperatures are less than **5 deg F (3 deg C)** above dew point.
3. Do not apply materials to damp or wet surfaces.
4. Do not apply primers, polyurethane foam, or coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period.
5. Do not apply polyurethane foam when wind conditions result in surface finish textures not complying with requirements.
6. Do not apply coatings when wind conditions prevent uniform coating application.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace coated foamed roofing that does not comply with requirements or that does not remain watertight within specified warranty period.

1. Warranty Period: [**Five**][**10**][**15**][**20**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain [**coating and polyurethane foam from single source from single manufacturer**][**coating from single source from single manufacturer and polyurethane foam from single manufacturer acceptable in writing to coating manufacturer**].

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Coated foamed roofing to withstand exposure to weather without failure due to defective manufacture, installation, or other defects in construction. Membrane roofing to remain watertight.

1. Material Compatibility: Provide polyurethane foam, coatings, substrate board, and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Fire-Test-Response Characteristics: Provide coated foamed roofing with the fire-test-response characteristics indicated, as determined by testing identical systems in accordance with test methods below for deck type and slopes indicated by a qualified testing and inspecting agency that is acceptable to authorities having jurisdiction.

1. [**Class A**][**Class B**][**Class C**] roof covering in accordance with ASTM E108.
2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**75**] or less.

3. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM 4474, UL 580, or UL 1897.

D. FM Approvals Listing: Provide roofing system and component materials that comply with requirements in [**FM Approvals Standard 4450 for steel roof decks and**]FM Approvals Standard 4470 for roof covers as part of a foamed roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-[**60**][**75**][**90**][**105**][**120**].
2. Hail-Resistance Classification: [**MH**][**SH**].

E. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**32**] or initial SRI not less than [**82**][**39**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

G. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

H. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [**64**][**15**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

I. Solar Reflectance Index: Not less than [**78**][**29**] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

J. Energy Star Listing: Provide coated foam roofing that is listed on the EPA/DOE's "Energy Star Roof Product List" for [**low**][**steep**]-slope roof products.

K. Energy Performance: Provide coated foamed roofing certified and labeled in accordance with one of the following when tested in accordance with ANSI/CRRC S100:

1. Three-year, aged solar reflectance of not less than [**0.55**] and emissivity of not less than [**0.75**].
2. Three-year, aged Solar Reflectance Index of not less than [**64**] when calculated in accordance with ASTM E1980.

2.3 POLYURETHANE FOAM

A. Polyurethane Foam: Rigid, cellular polyurethane; complying with ASTM C1029, [**Type III**][**Type IV**]; spray applied, with fire retardants as required, and acceptable to coating manufacturer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Conklin Company Inc**]
b. [**Gaco; Holcim Building Envelope**]
c. [**General Coatings Manufacturing Corp.**]
d. [**Huntsman Building Solutions**]
e. [**Master Builders Solutions**]
f. [**NCFI; Barnhart Manufacturing Co.**]
g. [**Neogard; Hempel Group**]
h. [**SWD Urethane Company**]
i. [**Volatile Free, Inc.**]

2. In-Place Density: **2.8 to 3.0 lb/cu. ft. (44.9 to 48.1 kg/cu. m)**; ASTM D1622/D1622M.

2.4 URETHANE COATINGS

A. Urethane Coating: Liquid urethane elastomeric coating system specifically formulated for coating spray-applied polyurethane foam roofing.[**One-component urethanes must comply with ASTM D6947/D6947M.**]

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aldo Products Inc.**]
b. [**ER Systems; a Holcim brand**]
c. [**Gaco; Holcim Building Envelope**]
d. [**GAF**]

e. [**Master Builders Solutions**]
f. [**NCFI; Barnhart Manufacturing Co.**]
g. [**Neogard; Hempel Group**]
h. [**Volatile Free, Inc.**]

2. Base Coat: [**One**][**Two**][**One- or two**]-component urethane[**color contrasting with topcoat**].
3. Topcoat: [**One**][**Two**][**One- or two**]-component urethane.

a. Color: [**White**][**Gray**][**Tan**].
b. Color at Walkways: [**White**][**Gray**][**Tan**].

4. Tensile Strength: **600 psi (4.1 MPa)** minimum in accordance with ASTM D2370.
5. Elongation: 350 percent minimum in accordance with ASTM D412 after 1000 hours accelerated weathering in accordance with ASTM D4798/D4798M.
6. Water Absorption: 3 percent maximum by weight in accordance with ASTM D471.
7. Fungal Resistance: Zero rating in accordance with ASTM G21.
8. Tear Resistance: **100 lbf/inch (17.5 kN/m)** minimum in accordance with ASTM D624.
9. Low-Temperature Flexibility: Pass **0.5-inch (12.5-mm)** mandrel at **minus 15 deg F (minus 26 deg C)** in accordance with ASTM D522/D522M.
10. Vapor Permeance: Minimum [**0.7 perm (40.2 ng/Pa x s x sq. m)**][**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.5 SILICONE COATINGS

A. Silicone Coating: Liquid silicone elastomeric coating system[**complying with ASTM D6694/D6694M and**] specifically formulated for coating spray-applied polyurethane foam roofing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aldo Products Inc.**]
b. [**ER Systems; a Holcim brand**]
c. [**Gaco; Holcim Building Envelope**]
d. [**GAF**]
e. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
f. [**General Coatings Manufacturing Corp.**]
g. [**Huntsman Building Solutions**]
h. [**Master Builders Solutions**]
i. [**NCFI; Barnhart Manufacturing Co.**]
j. [**Neogard; Hempel Group**]
k. [**Volatile Free, Inc.**]

2. Composition: [**One**][**Two**][**One- or two**]-component silicone.
3. Base-Coat Color: Contrasting with topcoat.
4. Topcoat Color: [**White**][**Gray**][**Tan**].
5. Topcoat Color at Walkways: [**White**][**Gray**][**Tan**].
6. Vapor Permeance: Minimum [**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.6 ACRYLIC COATINGS

A. Acrylic Coating: Liquid acrylic elastomeric emulsion coating system specifically formulated for coating spray-applied polyurethane foam roofing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aldo Products Inc.**]
b. [**Conklin Company Inc**]
c. [**ER Systems; a Holcim brand**]
d. [**Gaco; Holcim Building Envelope**]
e. [**GAF**]
f. [**General Coatings Manufacturing Corp.**]
g. [**Huntsman Building Solutions**]
h. [**NCFI; Barnhart Manufacturing Co.**]
i. [**Neogard; Hempel Group**]
j. [**SWD Urethane Company**]

2. Base-Coat Color: Contrasting with topcoat.
3. Topcoat Color: [**White**][**Gray**][**Tan**].
4. Topcoat Color at Walkways: [**White**][**Gray**][**Tan**].
5. Vapor Permeance: Minimum [**5.0 perms (286 ng/Pa x s x sq. m)**] at **20 mils (0.5 mm)** thick in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.

2.7 SUBSTRATE BOARD

A. Gypsum Board Thermal Barrier: ASTM C1396/C1396M, [**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**] thick.

B. Thermal Barrier Board: Board product tested in accordance with and meeting the requirements of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

C. Glass Mat Gypsum Thermal Barrier: Water-resistant gypsum board with fiberglass mat laminated to both sides, ASTM C1177/C1177M, [**1/2 inch (13 mm)**][**Type X, 5/8 inch (16 mm)**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**USG Corporation**]

D. Thermal-Barrier Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals Standard 4470, and designed and sized for fastening thermal barrier to substrate.

2.8 ACCESSORY MATERIALS

A. General: Accessory materials recommended in writing by roofing manufacturer for intended use.

1. Liquid-type accessory materials must comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants shall comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Primer: Polyurethane-foam manufacturer's standard factory-formulated primer.

C. Vapor Retarder: [**Fluid applied**][**Bituminous membrane**][**As recommended in writing by coated foamed roofing manufacturer**].

D. Mineral Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing **No. 8 (2.36-mm)** sieve and 98 percent of mass retained by **No. 40 (0.42-mm)** sieve.

1. Color: [**Buff white**][**Gray**][**Green**][**Red**]

E. Aggregate: Coarse mineral aggregate, **3/4 inch (19 mm)** maximum, ASTM D1863/D1863M, No. 7 or No. 67 gradation.

F. Reinforcement: Flexible polyester or fiberglass mat of weight, type, and composition recommended in writing by coating manufacturer for embedment in liquid coating.

G. Walkway Pads: Factory formed of nonwoven PVC strands, porous, UV stabilized, of **5/16-inch (8-mm)**

nominal thickness, and approved by coating manufacturer. Provide pad sizes indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Sika Greenstreak**]

2. Color: [**Yellow**][**Gray**][**Blue**][**Orange**][**Green**].

H. Sealant: ASTM C920, Class 25, Use NT, Grade NS, [**Type M, multicomponent urethane**][**Type S, one-component, neutral- or acid-curing silicone**], and as recommended in writing by coated foamed roofing manufacturer for substrate and joint conditions and for compatibility with roofing materials.

I. Sheet Flashing and Accessories: Types recommended in writing by coated foamed roofing manufacturer, provided at locations indicated and as recommended.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that related work is complete. Do not install coated foamed roofing until roof openings, curbs, and parapets, if any, are complete and roof drains, vents, and other roof penetrations are in place.

B. Examine substrates, areas, and conditions under which coated foamed roofing will be applied, with Installer present, for compliance with requirements.

C. Proceed with installation only after unsatisfactory conditions have been corrected and substrates are dry.

D. Proceed with installation only after minimum concrete curing and drying period recommended in writing by coated foamed roofing manufacturer.

E. Verify that concrete substrate is visibly dry and free of moisture. Test concrete substrate for capillary moisture by plastic sheet method in accordance with ASTM D4263[**at start of each day's work and**] at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under the plastic sheet.

3.2 INSTALLATION OF SUBSTRATE BOARD

A. General: Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

B. Thermal Barrier: [**Fasten to top flanges of steel deck in accordance with recommendations in FM Global's "Approval Guide" and its FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification**][**Fasten to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with coated foamed roofing manufacturer's written instructions**].

C. Recover Board: Install in accordance with coated foamed roofing manufacturer's written instructions and

the requirements in Section 070150.19 "Preparation for Re-Roofing." Fasten through existing roofing to roof structure as indicated. Space fasteners [**for wind-uplift conditions at Project site**][**as indicated**].

3.3 SURFACE PREPARATION

A. General: Clean and prepare substrate in accordance with coated foamed roofing manufacturer's written instructions. Provide clean, dust-free, dew-free, and dry substrate for coated foamed roofing application.

B. Remove grease, oil, form-release agents, curing compounds, and other contaminants from substrate.

C. Prepare substrate for re-covering in accordance with Section 070150.19 "Preparation for Re-Roofing" and to coated foamed roofing manufacturer's written instructions.

D. Cover and mask adjoining surfaces not receiving coated foamed roofing to prevent overspray or spillage affecting other construction. Temporarily close off roof drains, removing roof-drain plugs when not doing coated foamed roofing work or when rain is forecast.

1. Remove masking after polyurethane foam application; cover and re-mask adjoining surfaces before coating polyurethane foam.

E. Prime substrate as recommended in writing by coated foamed roofing manufacturer.

F. Fill, cover, or tape joints and cracks in substrate that exceed a width of **1/4 inch (6 mm)**. Remove dust and dirt from narrower joints and cracks before applying polyurethane foam.

G. Install vapor retarder in accordance with coated foamed roofing manufacturer's written instructions.

3.4 APPLICATION OF POLYURETHANE FOAM

A. General: Mix and apply polyurethane foam in accordance with ASTM D5469/D5469M and coated foamed roofing manufacturer's written instructions.

1. Fill irregularities and depressions to prevent ponding water.
2. Apply the required full thickness of polyurethane foam in any specific area on same day.
3. Apply only the area of polyurethane foam that can be covered with required base coating on same day or within 24 hours.
4. Apply polyurethane foam to avoid overspray beyond immediate area of work.

B. Apply polyurethane foam in lift thicknesses of not less than **1/2 inch (13 mm)** and not more than **1-1/2 inches (38 mm)**.

C. Uniformly apply total thickness of polyurethane foam indicated, but not less than **1 inch (25 mm)**, to a surface tolerance of plus **1/4 inch (6 mm)** and no minus.

1. Slope to Drain: Vary thickness uniformly and fill low spots to achieve minimum **1/4-inch-per-foot (1:48)** slope to drain unless otherwise indicated.

D. Apply polyurethane foam to roof penetrations, terminations, and vertical surfaces as indicated. Unless otherwise indicated, extend polyurethane foam at least **4 inches (100 mm)** above elevation of adjacent roof field.

E. Surface Finish: Provide finished surface of polyurethane foam within the following range of surface

textures as defined by ASTM D5469/D5469M:

1. Texture: Smooth to [**orange peel**][**coarse orange peel**][**verge of popcorn**].

F. Remove and replace polyurethane foam not complying with surface-texture limitations. Remove defective thickness and prepare and reapply polyurethane foam with acceptable, uniform results.

3.5 APPLICATION OF COATING

A. Allow polyurethane foam substrate to cure for a minimum of two hours before coating, and apply coating system to polyurethane foam no later than 24 hours after applying the foam. Remove dust, dirt, water, and other contaminants before applying coating system.

B. Apply coating system to polyurethane foam by spray, roller, or other suitable application method in accordance with coating manufacturer's written instructions.

C. Apply base coat and one or more topcoats to obtain a uniform, seamless membrane free of blisters and pinholes. Apply each coat at right angles to preceding coat, using contrasting color tints for successive coats.

1. Apply topcoat(s) after removing dust, dirt, water, and other contaminants from base coat.
2. Urethane Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 25 mils (0.64 mm)**][**of 30 mils (0.76 mm)**][**of 35 mils (0.89 mm)**].
3. Silicone Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 20 mils (0.50 mm)**][**of 22 mils (0.56 mm)**][**of 26 mils (0.66 mm)**][**of 30 mils (0.76 mm)**].
4. Acrylic Coating: Apply coating system to a minimum dry film thickness [**recommended in writing by coated foamed roofing manufacturer**][**of 25 mils (0.64 mm)**][**of 28 mils (0.71 mm)**][**of 32 mils (0.81 mm)**].

D. Height at Terminations: Apply coating system at wall terminations and other vertical surfaces to extend vertically beyond polyurethane foam by a minimum of **4 inches (100 mm)**.

E. Mineral Granules: Apply mineral granules over wet topcoat, using pressure equipment at the rate of [**0.5 lb/sq. ft. (2.45 kg/sq. m)**]. Remove excess granules after topcoat has cured.

F. Sealant: Apply sealant to perimeter and other terminations where indicated on Drawings or required by coated foamed roofing manufacturer.

G. Walkways: Install roof walkways in pattern and locations indicated and as follows:

1. Granule-Coated Walkways: Mask off completed coating adjacent to walkways, and apply one or two additional topcoats to achieve a minimum dry film thickness recommended in writing by coated foamed roofing manufacturer. Spread mineral granules uniformly at a rate of **0.5 lb/sq. ft. (2.45 kg/sq. m)** into final wet coating. Remove masking and excess granules after topcoat has cured.
2. Fabric-Reinforced, Granule-Coated Walkways: Mask off completed coating adjacent to walkways, and apply one additional topcoat to achieve a minimum dry film thickness recommended in writing by coated foamed roofing manufacturer. Lay reinforcing fabric into wet coating and apply another topcoat, completely filling fabric. Spread mineral granules uniformly at a rate of **0.5 lb/sq. ft. (2.45 kg/sq. m)** into final wet coating. Remove masking and excess granules after topcoat has cured.
3. Preformed Walkway-Pad Walkways: Adhere walkway pads to substrate with compatible adhesive in accordance with coated foamed roofing manufacturer's written instructions.

H. Aggregate: Apply aggregate uniformly over coated polyurethane foam at coated foamed roofing manufacturer's recommended rate, but not less than **6 lb/sq. ft. (29 kg/sq. m)** and a minimum thickness of **3/4 inch (19 mm)**. Spread with care to prevent puncturing coating and to minimize damage to substrate foam.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

1. Testing agency will identify, seal, and certify samples of materials taken from Project site, with Contractor present.
2. Testing agency will perform tests for product characteristics specified or cited in manufacturer's product data.

    a. Two core samples will be required for roof areas of up to **10,000 sq. ft. (900 sq. m)**, and one core sample will be required for each additional **10,000 sq. ft. (900 sq. m)** or part thereof.
    b. Six slit-test samples will be required for each **10,000 sq. ft. (900 sq. m)** of roof area to determine, as a minimum, the number of coats applied and dry film thickness of coating.

3. Testing agency will verify that surfaces slope to drain.

B. Coated foamed roofing will be considered defective if it does not pass tests and inspections.

C. Refill cores, repair slits, and re-coat test areas.

D. Prepare test and inspection reports.

3.7 REPAIR AND RE-COATING

A. Correct deficiencies in, or remove, foam or coatings that do not comply with requirements; fill and repair substrates and reapply materials.

B. Repair and re-coat coated foamed roofing in accordance with ASTM D6705/D6705M and manufacturer's written instructions.

3.8 CURING, PROTECTING, AND CLEANING

A. Cure coatings in accordance with manufacturer's written instructions, taking care to prevent contamination and damage during application stages and curing. Do not permit traffic on uncured coatings.

B. Protect coated foamed roofing from damage and wear during remainder of construction period.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 65 16 00B

SECTION 07 91 00 00 - PREFORMED JOINT SEALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preformed, foam joint seals.
2. Extruded-silicone joint seals.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for liquid sealants applied over preformed seals in dual-seal systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Preformed, foam joint seals.
2. Extruded-silicone joint seals.

B. Samples for Initial Selection: Manufacturer's color sheets, showing full range of available colors for each type of exposed preformed joint seal.

C. Samples for Verification: Actual samples of each type and color of exposed preformed joint seal.

1. Size: **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint seals.

D. Preformed Joint Seal Schedule: Include the following information:

1. Joint seal location and designation.
2. Joint width and movement capability.
3. Joint seal manufacturer and product name.
4. Joint seal color.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each preformed joint seal, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Sample warranties.

1.5 MOCKUPS

A. Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**and**][**to set quality standards for materials and execution**].

1. Build mockup [**as indicated on Drawings**].
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace preformed joint seals that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish preformed joint seals to repair or replace those that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For preformed joint seals, obtain each color, type, and variety of joint seal from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PREFORMED, FOAM JOINT SEALS

A. Preformed, Foam Joint Seals : Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of **10 lb/cu. ft. (160 kg/cu. m)** and impregnated with a nondrying, water-repellent agent. Factory produce them in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EMSEAL; a Sika Company**]
b. [**LymTal International, Inc.**]
c. [**MM Systems Corporation**]
d. [**Nystrom, Inc.**]
e. [**Pecora Corporation**]
f. [**Schul International Company, LLC**]

g. [**Watson Bowman Acme Corp.**]
h. [**Willseal LLC, part of Tremco CPG**]

2. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.3 EXTRUDED-SILICONE JOINT SEALS

A. Extruded-Silicone Joint Seals : Manufacturer's standard seal consisting of precured low-modulus silicone extrusion, with a neutral-curing silicone sealant for bonding extrusions to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
b. [**Nystrom, Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation**]
e. [**The Dow Chemical Company**]
f. [**Tremco Incorporated**]

2. Joint Seal Width: [**4 inches (102 mm)**][**Joint size indicated on Drawings plus 3/4 inch (19 mm)**][**Joint size indicated on Drawings plus 1 inch (25 mm)**]
3. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by preformed joint seal manufacturer for joint substrates indicated.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to preformed joint seal manufacturer, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces, and formulated to promote best adhesion to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with preformed joint seals and surfaces adjacent to joints.

D. Sealant for Adhering Extruded-Silicone Joint Seals: Silicone adhesive sealant recommended by extruded-silicone joint seal manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive preformed joint seals, with Installer present, for compliance with

requirements for joint configuration, installation tolerances, and other conditions affecting preformed joint seal performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing preformed joint seals to comply with preformed joint seal manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of preformed joint seal, including dust, paints (except for permanent protective coatings tested and approved for seal adhesion and compatibility by seal manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimal bond with preformed joint seals. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint seals. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by preformed joint seal manufacturer or as indicated by tests or prior experience. Apply primer to comply with joint seal manufacturer's written instructions. Confine primers to areas of joint seal bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of adhesive or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF PREFORMED, FOAM JOINT SEALS

A. General: Comply with preformed joint seal manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.

3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

3.4 INSTALLATION OF EXTRUDED-SILICONE JOINT SEALS

A. General: Comply with preformed joint seal manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

1. Apply masking tape to each side of joint, outside of area to be covered by seal system.
2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone seal system manufacturer's written instructions and covering a bonding area of not less than **3/8 inch (10 mm)**. Hold edge of sealant bead **1/4 inch (6 mm)** inside masking tape.
3. Press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact with substrate.
4. Complete installation of seal system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

3.5 PROTECTION

A. Protect preformed joint seals from damage resulting from construction operations or other causes so seals are without deterioration or damage at time of Substantial Completion.

B. Cut out, remove, and repair damaged or deteriorated seals so repaired areas are indistinguishable from original work.

END OF SECTION 07 91 00 00

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Task	Specification	Specification Description
07 91 23 00	07 91 00 00	Preformed Joint Seals
07 91 23 00	07 92 00 00	Joint Sealants
07 91 26 00	07 91 00 00	Preformed Joint Seals
07 91 26 00	07 92 00 00	Joint Sealants
07 91 33 00	07 91 00 00	Preformed Joint Seals

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SECTION 07 92 00 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

B. Related Requirements:

1. Section 079100 "Preformed Joint Seals" for preformed compressible foam and precured joint seals.
2. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.
3. Section 321373 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1.3 ACTION SUBMITTALS

A. Product Data:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:

1. Joint-sealant location and designation.
2. Manufacturer and product name.
3. Type of substrate material.
4. Proposed test.
5. Number of samples required.

B. Preconstruction Laboratory Test Reports: For each joint sealant and substrate material to be tested from sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

D. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturers' special warranties.

B. Installer's special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 MOCKUPS

A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint

sealants specified in this Section. Use materials and installation methods specified in this Section.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with [**stone**][**masonry**] substrates.
4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect, as directed by the Owner.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected, as directed by the Owner.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
5. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.

    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

6. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.9 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below 40 deg F (5 deg C)**].
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.10 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Five**] years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer[**for each sealant type**].

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.3 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Sika Corporation - Building Components**]

B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation - Building Components**]
e. [**The Dow Chemical Company**]

C. Silicone, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability. nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Premier Building Solutions**]
d. [**Sika Corporation - Building Components**]
e. [**The Dow Chemical Company**]

D. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
b. [**Pecora Corporation**]
c. [**Permathane; a Holcim brand**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]
f. [**Sika Corporation - Building Components**]
g. [**The Dow Chemical Company**]

E. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Bostik; Arkema**]
c. [**Everkem Diversified Products, Inc.**]
d. [**Pecora Corporation**]
e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
f. [**PPG Paints; PPG Industries, Inc.**]
g. [**Premier Building Solutions**]
h. [**Sika Corporation - Building Components**]
i. [**The Dow Chemical Company**]

F. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pecora Corporation**]
b. [**The Dow Chemical Company**]

G. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Soudal Accumetric**]
b. [**The Dow Chemical Company**]

H. Silicone, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Pecora Corporation**]
b. [**Sika Corporation - Building Components**]

I. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Pecora Corporation**]

J. Silicone, M, P, 100/50, T, NT: Multicomponent, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade P, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**The Dow Chemical Company**]

2.4 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Pecora Corporation**]
c. [**Sika Corporation - Building Components**]
d. [**Tremco Incorporated**]

C. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Pecora Corporation**]
d. [**Sika Corporation - Building Components**]
e. [**Soudal Accumetric**]
f. [**The Dow Chemical Company**]
g. [**Tremco Incorporated**]

D. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**The Dow Chemical Company**]

E. Silicone, Nonstaining, M, NS, 50, NT: Nonstaining, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

2.5 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Bostik; Arkema**]
c. [**Everkem Diversified Products, Inc.**]
d. [**Master Builders Solutions**]
e. [**Pecora Corporation**]
f. [**Permathane; a Holcim brand**]
g. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
h. [**PPG Paints; PPG Industries, Inc.**]

i. [**Sherwin-Williams Company (The)**]
j. [**Sika Corporation - Building Components**]
k. [**Tower Sealants, Inc.**]
l. [**Tremco Incorporated**]

B. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

C. Urethane, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]
b. [**Master Builders Solutions**]

D. Urethane, S, P, 35, T, NT: Single-component, pourable, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 35, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]

E. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Pecora Corporation**]
c. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
d. [**Sherwin-Williams Company (The)**]

F. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Pecora Corporation**]

G. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Sherwin-Williams Company (The)**]

H. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

I. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**LymTal International, Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]

J. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]

K. Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bostik; Arkema**]
b. [**LymTal International, Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]
e. [**Sherwin-Williams Company (The)**]
f. [**Tremco Incorporated**]

2.6 IMMERSIBLE JOINT SEALANTS

A. Immersible Joint Sealants: Suitable for immersion in liquids; ASTM C1247, [**Class 1**][**Class 2**]; tested in deionized water unless otherwise indicated.

B. Urethane, Immersible, S, NS, 100/50, NT, I: Immersible, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

C. Urethane, Immersible, S, NS, 35, NT, I: Immersible, single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]

D. Urethane, Immersible, S, NS, 50, T, NT, I: Immersible, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

E. Urethane, Immersible, S, NS, 35, T, NT, I: Immersible, single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]

F. Urethane, Immersible, S, NS, 25, T, NT, I: Immersible, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Pecora Corporation**]
c. [**Tremco Incorporated**]

G. Urethane, Immersible, S, P, 50, T, NT, I: Immersible, single-component, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]

H. Urethane, Immersible, S, P, 25, T, NT, I: Immersible, single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Tremco Incorporated**]
b. [**W. R. Meadows, Inc**]

I. Polysulfide, Immersible, M, NS, 25, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and

minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses NT and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]

J. Urethane, Immersible, M, NS, 50, T, NT, I: Immersible, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**LymTal International, Inc.**]
    b. [**Tremco Incorporated**]

K. Urethane, Immersible, M, NS, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Master Builders Solutions**]

L. Polysulfide, Immersible, M, NS, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Pecora Corporation**]

M. Urethane, Immersible, M, P, 25, T, NT, I: Immersible, multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LymTal International, Inc.**]
b. [**Master Builders Solutions**]

2.7 SILANE-MODIFIED POLYMER JOINT SEALANTS

A. Silane-Modified Polymer, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
c. [**Master Builders Solutions**]
d. [**Pecora Corporation**]
e. [**Premier Building Solutions**]
f. [**Sherwin-Williams Company (The)**]
g. [**Sika Corporation - Building Components**]
h. [**Soudal Accumetric**]

B. Silane-Modified Polymer, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Master Builders Solutions**]
b. [**Premier Building Solutions**]
c. [**Sika Corporation - Building Components**]
d. [**Tremco Incorporated**]

C. Silane-Modified Polymer, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Everkem Diversified Products, Inc.**]
b. [**Franklin International**]
c. [**Permathane; a Holcim brand**]
d. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
e. [**Sika Corporation - Building Components**]

D. Silane-Modified Polymer, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 100, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Soudal Accumetric**]
    b. [**Sto Corp.**]

E. Silane-Modified Polymer, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Franklin International**]
    b. [**Soudal Accumetric**]

F. Silane-Modified Polymer, S, NS, 35, T, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 35, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Soudal Accumetric**]

G. Silane-Modified Polymer, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Soudal Accumetric**]

H. Silane-Modified Polymer, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Franklin International**]
    b. [**Premier Building Solutions**]
    c. [**Soudal Accumetric**]

2.8 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Adfast**]
    b. [**GE Construction Sealants; Momentive Performance Materials Inc.**]
    c. [**Pecora Corporation**]
    d. [**PPG Paints; PPG Industries, Inc.**]
    e. [**Sika Corporation - Building Components**]
    f. [**Soudal Accumetric**]
    g. [**The Dow Chemical Company**]
    h. [**Tremco Incorporated**]

C. Silane-Modified Polymer, Mildew Resistant, S, NS, 50, NT: Mildew-resistant, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, [**silyl-terminated polyether**][**silyl-terminated polyurethane**][**polyurea**] joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Master Builders Solutions**]

2.9 POLYSULFIDE JOINT SEALANTS

A. Polysulfide, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**W. R. Meadows, Inc**]

B. Polysulfide, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**W. R. Meadows, Inc**]

C. Polysulfide, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, polysulfide joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**W. R. Meadows, Inc**]

2.10 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bostik; Arkema**]
    b. [**Everkem Diversified Products, Inc.**]
    c. [**GSSI Sealants**]
    d. [**Pecora Corporation**]
    e. [**Sika Corporation - Building Components**]

2.11 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Adfast**]
b. [**Everkem Diversified Products, Inc.**]
c. [**Franklin International**]
d. [**Pecora Corporation**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. [**Tremco Incorporated**]

2.12 JOINT-SEALANT BACKING

A. Sealant Backing Material: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adfast**]
b. [**Alcot Plastics Ltd.**]
c. [**Construction Foam Products; a division of Nomaco, Inc.**]
d. [**Master Builders Solutions**]

B. Cylindrical Sealant Backings: ASTM C1330, [**Type C (closed-cell material with a surface skin)**][**Type O (open-cell material)**][**Type B (bicellular material with a surface skin)**][**or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated**], and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.13 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at [**locations indicated on Drawings**] in accordance with Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and at [**locations indicated on Drawings**] in accordance with Figure 8C in ASTM C1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

a. Extent of Testing: Test completed and cured sealant joints as follows:

1) Perform [**10**] tests for the first [**1000 ft. (300 m)**] of joint length for each kind of sealant and joint substrate.
2) Perform one test for each [**1000 ft. (300 m)**] of joint length thereafter or one test per each floor per elevation.

b. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

c. Inspect tested joints and report on the following:

1) Whether sealants filled joint cavities and are free of voids.
2) Whether sealant dimensions and configurations comply with specified requirements.
3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

C. Prepare test and inspection reports.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

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Task	Specification	Specification Description
07 92 13 00	07 92 00 00	Joint Sealants

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SECTION 07 92 19 00 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Acoustical joint sealants.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for nonacoustical applications.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants, showing full range of available colors for each product exposed to view.

C. Samples for Verification: For each type and color of acoustical joint sealant required.

1. Size: **1/2-inch- (13-mm-)** wide sealant joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Acoustical Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

E. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each type of acoustical joint sealant, for tests performed by [**qualified testing agency**][**manufacturer and witnessed by a qualified testing agency**].

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained between **40 and 95 deg F (4 and 35 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between [**35 and 100 deg F (2 and 38 deg C)**][**60 and 90 deg F (16 and 32 deg C)**].[**Warm surfaces to be coated to 70 deg F (21 deg C) to enhance drying.**]

1.7 WARRANTY

A. Installer's Special Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: [**Two**] years from date of Substantial Completion.

B. Manufacturer's Special Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

PART 2 - PRODUCTS

2.1 ACOUSTICAL JOINT SEALANTS

A. Acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies in accordance with ASTM E90.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**DAP Products Inc.**]
b. [**Everkem Diversified Products, Inc.**]
c. [**Franklin International**]
d. [**Grabber Construction Products, Inc.**]
e. [**Hilti, Inc.**]
f. [**OSI Sealants; Henkel Corporation**]
g. [**Pecora Corporation**]
h. [**Specified Technologies Inc.**]

2. Colors of Exposed Acoustical Joint Sealants: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range of colors**], as directed by the Owner.

C. Acoustical Sealant for Concealed Joints: Manufacturer's standard nonsag, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber acoustical sealant.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**OSI Sealants; Henkel Corporation**]
b. [**Pecora Corporation**]
c. [**Tremco Incorporated**]
d. [**USG Corporation**]

2.2 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by acoustical joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written instructions for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage

or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 92 19 00

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Task	Specification	Specification Description
07 92 19 00	07 92 00 00	Joint Sealants

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SECTION 07 95 13 00 - PARKING DECK EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Parking deck expansion joint covers.

B. Related Requirements:

1. Section 079100 "Preformed Joint Seals" for preformed foam and extruded-silicone joint seals.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Parking deck expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.
6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement: As indicated on Drawings.

2.3 PARKING DECK EXPANSION JOINT COVERS

A. Metal-Plate Parking Deck Joint Cover : Assembly consisting of metal cover plate in continuous contact with metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**LymTal International, Inc.**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]
i. [**Willseal LLC, part of Tremco CPG**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Installation: [**Surface mounted**][**Recessed**][**No bump**].
4. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

   a. Aluminum: [**Mill**][**Manufacturer's standard**].
   b. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

B. T-Joint Parking Deck Joint Cover : Assembly consisting of factory-formed polyurethane block with tapered edges over steel plate. Provide manufacturer's standard, liquid-applied nosing sealant for preformed voids at tapered edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Balco; a CSW Industrials Company**]
   b. [**Erie Metal Specialties, Inc.**]
   c. [**LymTal International, Inc.**]
   d. [**MM Systems Corporation**]
   e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Exposed Metal:

a. Aluminum: [**Mill**][**Manufacturer's standard**].
b. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

6. Polyurethane Block:

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Compression-Seal Parking Deck Joint Cover : Complying with ASTM E1612/E1612M. Elastomeric seal designed to always stay in compression. Install using manufacturer's recommended lubricant adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**D.S. Brown; a Gibraltar Industries company**]
e. [**Erie Metal Specialties, Inc.**]
f. [**inpro Corporation**]
g. [**LymTal International, Inc.**]
h. [**MM Systems Corporation**]
i. [**Nystrom, Inc.**]
j. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

D. Precompressed Foam Parking Deck Expansion Joint Seals : Manufacturer's precompressed, self-expanding foam joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam, impregnated with a nondrying, water-repellent agent, and coated with traffic-grade silicone wearing surface. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Balco; a CSW Industrials Company**]
b. [**EMSEAL; a Sika Company**]

c. [**Willseal LLC, part of Tremco CPG**]

2. Design Criteria:

   a. Nominal Joint Width: [**As indicated on Drawings**].
   b. Minimum Joint Width: [**As indicated on Drawings**].
   c. Maximum Joint Width: [**As indicated on Drawings**].

3. Application: Slab to slab.
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Joint Seal Color: [**Gray**][**As indicated by manufacturer's designations**].

E. Epoxy-Bonded-Seal Parking Deck Joint Covers : Elastomeric seal, epoxy-bonded to sides of joint gap. Install using manufacturer's recommended epoxy adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**D.S. Brown; a Gibraltar Industries company**]
   e. [**Erie Metal Specialties, Inc.**]
   f. [**LymTal International, Inc.**]
   g. [**MM Systems Corporation**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

   a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
   b. Concentrated Load: [**2000 lb (907 kg)**].
   c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Strip-Seal Parking Deck Joint Covers : Complying with ASTM E1783/E1783M. Assembly consisting of elastomeric seal mechanically locked into a metal frame or edge rails cast into slab edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**D.S. Brown; a Gibraltar Industries company**]
   b. [**Erie Metal Specialties, Inc.**]

c. [**inpro Corporation**]
d. [**LymTal International, Inc.**]
e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Winged-Seal Parking Deck Joint Covers : Winged elastomeric seal grouted into block outs without mechanical attachment. Fully grout block out with manufacturer's elastomeric concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**D.S. Brown; a Gibraltar Industries company**]
e. [**EMSEAL; a Sika Company**]
f. [**Erie Metal Specialties, Inc.**]
g. [**inpro Corporation**]
h. [**LymTal International, Inc.**]
i. [**MM Systems Corporation**]
j. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
b. Concentrated Load: [**2000 lb (907 kg)**].
c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

H. Bolt-In Parking Deck Joint Cover : Assembly consisting of winged elastomeric seal locked into slab-edge block outs by metal frames bolted to slab. Fully grout block outs with elastomeric concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**LymTal International, Inc.**]
    d. [**MM Systems Corporation**]
    e. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

    a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
    b. Concentrated Load: [**2000 lb (907 kg)**].
    c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Seal: Preformed elastomeric extrusion.

    a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

I. Split-Slab Membrane Parking Deck Joint Cover : Designed for use with slabs to receive toppings. Assembly consisting of elastomeric winged seals locked into metal edge rails, with flashing for hot-splicing into deck waterproofing. Provide stainless steel retaining caps for edge rails.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Balco; a CSW Industrials Company**]
    b. [**Construction Specialties, Inc.**]
    c. [**EMSEAL; a Sika Company**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**LymTal International, Inc.**]
    f. [**MM Systems Corporation**]
    g. [**Watson Bowman Acme Corp.**]

2. Application: [**Slab to slab**][**Slab to wall**].
3. Load Capacity:

    a. Uniform Load: [**200 lb/sq. ft. (976 kg/sq. m)**].
    b. Concentrated Load: [**2000 lb (907 kg)**].
    c. Maximum Deflection: [**0.125 inch (3.2 mm)**].

4. Height: [**To match adjacent topping materials**].
5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Exposed Metal:

a. Stainless steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].

7. Seal: Preformed elastomeric extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**, Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

D. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.

E. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

F. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

G. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.6 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's stainless steel attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

C. Cast-In Frames: Coordinate and furnish frames to be cast into concrete.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Repair or grout block out as required for continuous frame support, using nonmetallic, shrinkage-resistant grout.
2. Install frames in continuous contact with adjacent surfaces.
    a. Shimming is not permitted.
3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
6. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written

instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer before installing compression seals.

E. Precompressed Foam Parking Deck Expansion Joint Seals:

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

F. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not overpressurize.

G. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

H. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

I. Elastomeric Concrete: Install according to manufacturer's written application instructions.

J. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work, so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

K. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals, and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 07 95 13 00

SECTION 07 95 13 13 - INTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor expansion joint covers.
2. Wall expansion joint covers.
3. Ceiling expansion joint covers.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Floor expansion joint covers.
2. Wall expansion joint covers.
3. Ceiling expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric-seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.
6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to [**UL 2079**][**or**][**ASTM E1966**] by a qualified testing agency.

1. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies to be subjected to hose stream testing.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement:

a. Joint Movement: As indicated on Drawings.

2.3 FLOOR EXPANSION JOINT COVERS

A. Metal-Plate Floor Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Surface mounted.
4. Load Capacity:

a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
b. Concentrated Load: [**300 lb (136 kg)**].
c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Floor Joint Cover : Assembly consisting of center plate that slides over metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]

f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: [**Surface mounted**][**Recessed**][**No bump**].
4. Load Capacity:

   a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
   b. Concentrated Load: [**300 lb (136 kg)**].
   c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Cover-Plate Design: [**Plain**][**Serrated**][**Abrasive covered**].
7. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Floor Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**Erie Metal Specialties, Inc.**]
   e. [**inpro Corporation**]
   f. [**MM Systems Corporation**]
   g. [**Nystrom, Inc.**]
   h. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

   a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
   b. Concentrated Load: [**300 lb (136 kg)**].
   c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent**

construction][**1 hour**][**2 hours**].

6. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

D. Hidden-Sightline Floor Joint Cover : Sliding leaf-spring and metal frame assembly designed to accept field-applied finish materials on visible surfaces for minimum frame exposure.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Balco; a CSW Industrials Company**]
    b. [**Construction Specialties, Inc.**]
    c. [**inpro Corporation**]
    d. [**MM Systems Corporation**]
    e. [**Nystrom, Inc.**]
    f. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

    a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
    b. Concentrated Load: [**300 lb (136 kg)**].
    c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

E. Seismic-Pan Floor Joint Cover : Seismic pan assembly with sloped sides allowing extension of unit above floor plane during joint contraction, and equipped with springs to return unit back into alignment during joint expansion. Provide manufacturer's recommended sealant at pan edge.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**inpro Corporation**]
    e. [**Nystrom, Inc.**]
    f. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

    a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
    b. Concentrated Load: [**300 lb (136 kg)**].
    c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Pan Recess Depth: [**As required to accommodate adjacent flooring**][**1 inch (25 mm)**][**1-1/2 inch (38 mm)**].

F. Elastomeric-Seal Floor Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**EMSEAL; a Sika Company**]
    e. [**Erie Metal Specialties, Inc.**]
    f. [**inpro Corporation**]
    g. [**MM Systems Corporation**]
    h. [**Nystrom, Inc.**]
    i. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: [**Surface mounted**][**Recessed**].
4. Load Capacity:

    a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
    b. Concentrated Load: [**300 lb (136 kg)**].
    c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].

d. Brass: [**Mill**][**Manufacturer's standard**].

7. Seal: Preformed elastomeric membrane or extrusion.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

G. Dual-Elastomeric-Seal Floor Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Floor to floor**][**Floor to wall**].
3. Installation: Recessed.
4. Load Capacity:

a. Uniform Load: [**50 lb/sq. ft. (244 kg/sq. m)**].
b. Concentrated Load: [**300 lb (136 kg)**].
c. Maximum Deflection: [**0.0625 inch (1.6 mm)**].

5. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
6. Center-Plate Design: [**Plain**][**Serrated**][**Recessed to accept field-applied finish materials**].

a. Center-Plate Recess Depth: [**As required to accommodate adjacent flooring**][**1/8 inch (3 mm)**][**3/8 inch (10 mm)**].

7. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

8. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.4 WALL EXPANSION JOINT COVERS

A. Metal-Plate Wall Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Wall Joint Cover : Assembly consisting of center plate that slides over gaskets in metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

4. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Wall Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**inpro Corporation**]
    f. [**MM Systems Corporation**]
    g. [**Nystrom, Inc.**]
    h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

D. Elastomeric-Seal Wall Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]

b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

5. Seal: Preformed elastomeric membranes or extrusions.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Dual-Elastomeric-Seal Wall Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
   b. [**Balco; a CSW Industrials Company**]
   c. [**Construction Specialties, Inc.**]
   d. [**inpro Corporation**]
   e. [**MM Systems Corporation**]
   f. [**Nystrom, Inc.**]
   g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Center-Plate Design: [**Plain**][**Recessed to accept gypsum board**][**Recessed to accept wall tile**].
5. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class**

I][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.5 CEILING EXPANSION JOINT COVERS

A. Metal-Plate Ceiling Joint Cover : Metal cover plate fixed on one side of joint gap and free to slide on other.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

B. Center-Plate Ceiling Joint Cover : Assembly consisting of center plate that slides over gasket in metal frames fixed to sides of joint gaps.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**Nystrom, Inc.**]
f. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

C. Glide-Plate Ceiling Joint Cover : Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

D. Elastomeric-Seal Ceiling Joint Cover : Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**Erie Metal Specialties, Inc.**]
e. [**inpro Corporation**]
f. [**MM Systems Corporation**]
g. [**Nystrom, Inc.**]
h. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

4. Seal: Preformed elastomeric membranes or extrusions.

a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

E. Dual-Elastomeric-Seal Ceiling Joint Cover: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]

2. Application: [**Wall to wall**][**Wall to corner**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Center-Plate Design: [**Plain**][**Recessed to accept gypsum board**][**Recessed to accept wall tile**].
5. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membranes or extrusions.

    a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

F. Elastomeric-Seal Acoustical Ceiling Joint Cover : Elastomeric-seal assembly designed for use in acoustical ceilings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
    b. [**Balco; a CSW Industrials Company**]
    c. [**Construction Specialties, Inc.**]
    d. [**Erie Metal Specialties, Inc.**]
    e. [**inpro Corporation**]
    f. [**Nystrom, Inc.**]
    g. [**Watson Bowman Acme Corp.**]

2. Application: [**Ceiling to ceiling**][**Wall to ceiling**].
3. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
4. Exposed Metal:

    a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

        1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**].

    b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
    c. Bronze: [**Mill**][**Manufacturer's standard**].
    d. Brass: [**Mill**][**Manufacturer's standard**].

5. Seal: Preformed elastomeric membranes or extrusions.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

2.6 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**, Alloy 6061-T6 for sheet and plate.

   1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Brass: ASTM B36/B36M, UNS Alloy C26000 for half hard sheet and coil.

D. Bronze: ASTM B455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.

E. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

F. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

G. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

H. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

2.8 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

   1. Run grain of directional finishes with long dimension of each piece.
   2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.9 COPPER-ALLOY FINISHES

A. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

B. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

2.10 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's [**standard**][**stainless steel**] attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage-resistant grout.

2. Install frames in continuous contact with adjacent surfaces.

   a. Shimming is not permitted.

3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
6. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

F. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

G. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 07 95 13 13

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Task	Specification	Specification Description
07 95 13 13	07 95 13 00	Parking Deck Expansion Joint Cover Assemblies

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SECTION 07 95 13 16 - EXTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior expansion joint covers.

B. Related Requirements:

1. Section 077129 "Manufactured Roof Expansion Joints" for factory-fabricated roof expansion joint cover assemblies.
2. Section 079100 "Preformed Joint Seals" for preformed foam and extruded-silicone joint seals.
3. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for expansion joint cover assemblies subject to vehicular traffic.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Exterior expansion joint covers.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each exposed expansion joint cover assembly and for each color and texture specified, full width by **6 inches (150 mm)** long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by **6 inches (150 mm)** long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.

6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to [**UL 2079**][**ASTM E1966**] by a qualified testing agency.

1. Hose Stream Test: Wall-to-wall and wall-to-soffit assemblies shall be subjected to hose stream testing.

C. Expansion Joint Design Criteria :

1. Type of Movement: [**Thermal**][**Wind sway**].

a. Nominal Joint Width: [**As indicated on Drawings**].
b. Minimum Joint Width: [**As indicated on Drawings**].
c. Maximum Joint Width: [**As indicated on Drawings**].

2. Seismic Movement:

a. Joint Movement: As indicated on Drawings.

2.3 EXTERIOR EXPANSION JOINT COVERS

A. Exterior Metal-Plate Joint Cover : Assembly consisting of sliding metal cover plate in continuous contact with gaskets mounted on metal frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to soffit**][**Soffit to soffit**].
3. Installation: Surface mounted.
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent construction**][**1 hour**][**2 hours**].
5. Exposed Metal:

a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
c. Bronze: [**Mill**][**Manufacturer's standard**].
d. Brass: [**Mill**][**Manufacturer's standard**].

B. Exterior Elastomeric-Seal Joint Cover : Assembly consisting of elastomeric seal anchored to surface-mounted frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC**]
b. [**Balco; a CSW Industrials Company**]
c. [**Construction Specialties, Inc.**]
d. [**inpro Corporation**]
e. [**MM Systems Corporation**]
f. [**Nystrom, Inc.**]
g. [**Watson Bowman Acme Corp.**]

2. Application: [**Wall to wall**][**Wall to soffit**][**Soffit to soffit**].
3. Installation: [**Surface-mounted**][**Recessed**].
4. Fire-Resistance Rating: Not less than [**that indicated on Drawings**][**that of adjacent**

construction][**1 hour**][**2 hours**].

5. Exposed Metal:

   a. Aluminum: [**Mill**][**Clear anodic, Class I**][**Clear anodic, Class II**][**Color anodic, Class I**][**Color anodic, Class II**][**Manufacturer's standard**].

      1) Color: [**Light bronze**][**Dark bronze**][**Match Architect's sample**][**As selected by Architect from full range of industry colors and color densities**], as directed by the Owner.

   b. Stainless Steel: [**No. 2B**][**No. 4**][**Manufacturer's standard**].
   c. Bronze: [**Mill**][**Manufacturer's standard**].
   d. Brass: [**Mill**][**Manufacturer's standard**].

6. Seal: Preformed elastomeric membrane or extrusion.

   a. Color: [**Black**][**Gray**][**As selected by Architect from manufacturer's full range**], as directed by the Owner.

C. Preformed Foam Joint Seals: Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of **10 lb/cu. ft. (160 kg/cu. m)** and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Balco; a CSW Industrials Company**]
   b. [**EMSEAL; a Sika Company**]
   c. [**LymTal International, Inc.**]
   d. [**MM Systems Corporation**]
   e. [**Nystrom, Inc.**]
   f. [**Pecora Corporation**]
   g. [**Schul International Company, LLC**]
   h. [**Watson Bowman Acme Corp.**]
   i. [**Willseal LLC, part of Tremco CPG**]

2. Design Criteria:

   a. Nominal Joint Width: [**As indicated on Drawings**].
   b. Minimum Joint Width: [**As indicated on Drawings**].
   c. Maximum Joint Width: [**As indicated on Drawings**].

3. Joint Seal Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from full range of industry colors**], as directed by the Owner.

2.4 MATERIALS

A. Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5 for extrusions; **ASTM B209 (ASTM B209M)**,

Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.

C. Brass: ASTM B36/B36M, UNS Alloy C26000 for half hard sheet and coil.

D. Bronze: ASTM B455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.

E. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

F. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

G. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

2.5 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**][**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**][**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

2.6 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Directional Satin Finish: No. 4.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

2.7 COPPER-ALLOY FINISHES

A. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

B. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

2.8 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's [**standard**][**stainless steel**] attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance, as directed by the Owner.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
4. Install frames in continuous contact with adjacent surfaces.

a. Shimming is not permitted.

5. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.

C. Elastomeric Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Preformed Foam Joint Seals: Install in compliance with manufacturer's written instructions. Install with minimum number of end joints.

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

E. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

F. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

G. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

H. Moisture Barrier Drainage: If indicated, provide drainage fitting and connect to drains.

3.4 CONNECTIONS

A. Transition to Roof Expansion Joint Covers: Coordinate installation of exterior wall and soffit expansion joint covers with roof expansion joint covers specified in Section 077129 "Manufactured Roof Expansion Joints."[**Install factory-fabricated units at transition between exterior walls and soffits and roof expansion joint cover assemblies.**]

3.5 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections.

END OF SECTION 07 95 13 16

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Task	Specification	Specification Description
07 95 13 16	07 95 13 13	Interior Expansion Joint Cover Assemblies
07 95 13 16	07 95 13 00	Parking Deck Expansion Joint Cover Assemblies

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SECTION 09 01 20 00 - GYPSUM BOARD RENOVATION

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of materials for gypsum board renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Submittals

2. Quality Assurance/Control Submittals
   a. Certificates: Manufacturer's written certification that gypsum products meet or exceed specified requirements.

Quality Assurance

3. Regulatory Requirements:
   a. Gypsum Board Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
   b. Gypsum Board Floor/Ceilings and Roof/Ceiling Assemblies: Listed and labeled for fire protective ratings as indicated or scheduled.
   c. Fire-Rated Assemblies: Comply with UL 05, FM P8016, or GA 600 for required fire-rated assembly.

Delivery, Storage, And Handling

4. Storage and Protection: Store wallboard off ground to protect it from weather and damage due to moisture damage.
   a. Wallboard: Dry, free of warpage, and have bundling tape intact immediately prior to use.

Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
   a. During gypsum-panel application and finishing, maintain indoor temperatures within range of 13 degrees C (55 degrees F) to 21 degrees C (70 degrees F). Provide adequate ventilation to carry off excess moisture.
6. Existing Conditions: See Division 1 Section “Summary of Work”. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
7. Protection: Protect grounds, plantings, buildings and any other facilities or property from damage caused by construction operations.

Scheduling And Sequencing

8. Scheduling and Completion: Comply with Detailed Scope of Work.

PRODUCTS

Materials

9. Materials for Patching, Extending, and Matching:

a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
   1) Generally, Contract Documents will not define products present in existing construction. Determine products by Inspection and any necessary testing.
   2) Patching, extending, and matching of existing work and systems shall result in a complete, finished system.
b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.

Metals

10. Partition Metals: ASTM C 645, galvanized steel:
    a. Interior Steel Studs: Minimum 0.46 mm (25 gage), provide sizes and gages to match existing or as indicated.
       1) Provide minimum of 0.84 mm (20 gage) studs both sides of hollow metal frames.
    b. Steel Stud Runners: Match studs. Provide long leg runners for slip joint at structure above to allow for deflection.
    c. Furring Channels: Hat-shaped furring channels, minimum 0.46 mm (25 gage).
    d. Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission by resilient attachment of gypsum board, 13 mm (1/2 inch) deep.
    e. Sheet-Metal Reinforcement (Alternate to Wood Blocking): 1.52 mm (16 gage) minimum.
11. Suspended Coiling Metals:
    a. Runner Channels: ASTM C 754 cold-rolled steel channels with rust-inhibitive finish.
       1) 50 mm (2 Inches) deep, 88 kg per 100 m (590 pounds per 1,000 LF).
       2) 38 mm (1-1/2 inch) deep, 70 kg per 100 m (475 pounds per 1,000 LF).
       3) 19 mm (3/4 Inch) deep, 45 kg per 100 m (300 pounds per 1,000 LF).
    b. Furring Channels: Hat-shaped galvanized-steel furring channels, minimum 0.46 mm (25 gage).
    c. Steel Studs: Galvanized steel as specified above, minimum 0.46 mm (25 gage).
    d. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
       1) Hanger Wire: Minimum 4.1 mm (8 gage).
       2) Tie Wire: 6 mm (16 gage).

Gypsum Board And Related Materials

12. Gypsum Board: GA216 and ASTM C 36
    a. Size: 12.7 mm and 15.9 mm (1/2 inch and 5/8 inch) thick to match existing, as indicated or scheduled. Provide boards 1 200 mm (48 inches) wide by length required to minimize cross joints.
    b. Regular Tapered-edge gypsum panels.
       1) Provide Type X gypsum panels at fire-rated assemblies.
    c. Water-Resistant: ASTM C 630, paintable, tapered-edge gypsum panels.
       1) Provide Type X water-resistant gypsum panels at fire-rated assemblies.
13. Cementitious Backer Units (CBU): ANSI A118.9, nailable/screwable backer board composed of stable Portland cement, aggregates, and reinforcements with ability to remain unaffected by prolonged exposure to moisture, 12.7 mm (112 inch) thick.
14. Fasteners:
    a. Screws: ASTM C 1002, drywall screws, corrosion resistant. Provide types as recommended by manufacturer for each application.
       1) Wallboard to Metal Framing: Minimum 25 mm (1 inch), Type S.
       2) Wall board to Wood Framing: Minimum 32 mm (1-1/4 inch) Type W bugle head.

3) Wall board to Wallboard: Type G.
b. Nails: ASTM C 514.

15. Accessories: GA 216 and ASTM C 1047, galvanized steel.
    a. Comer Bead: GA 216 Type CB-114 x 114.
    b. Metal Trim (Casing Beads): GA 216 Type L, in depth to match gypsum-board thickness.
    c. Control Joint: V-shaped control joint.
    d. Adhesive: ASTM C 557 multi-purpose adhesive.
16. Finishing Materials: ASTM C 475.
    a. Joint Tape: Provide type as recommended by panel manufacturer.
    b. Joint Treatment: Joint compound, adhesive, water, and fasteners.
17. Sound-Isolation Materials:
    a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral fiber blankets, 3.7 to 4.9 kg per sq m (3/4 to 1 PCF), thickness as indicated, scheduled, or required by fire-rated assembly.
    b. Acoustical Sealant:
        1) Concealed: ASTM C 919 nondrying, non-hardening, and non-skinning; non-bleeding; and non-staining.
        2) Exposed: ASTM C 919 non-oxidizing and skinning; permanently elastic; and paintable.
    c. Ductwork Penetrations Packing: Low-density fiberglass.

EXECUTION

Examination

18. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
    a. Existing Conditions: Before beginning installation, examine substrates and framing to receive gypsum board for defects or conditions adversely affecting quality and execution of installation.

Preparation

19. Dust Protection: Comply with Detailed Scope of Work.
20. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
21. Protection: Comply with Detailed Scope of Work.
    a. Protection: Provide drapes and drop cloths necessary to protect walls, floors, ductwork and piping, electrical work, etc. during drywall finishing operations.
22. Selective Demolition: Comply with Detailed Scope of Work.

Laying Out Work

23. Discrepancies: Verity dimensions and elevations indicated in layout of existing work.
    a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
    b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner or adjustment before work affected is performed.
        1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike mariner.
    c. Contractor: Responsible for location and elevation of construction indicated by Construction Documents.

Performance

24. Patching: Patch and extend existing work using skilled mechanics capable of matching existing quality of workmanship.
    a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
25. Damaged Surfaces: Comply with Detailed Scope of Work.
26. Transitions from Existing to New Work: Comply with Detailed Scope of Work.

Erection Of Drywall Stud Partitions

27. Reference Standard: Erect steel framing in accordance with ASTM C 754.
28. Layouts: Align partition studs accurately according to partition layout.
29. Anchoring: Anchor runner channels to concrete slabs with concrete stub nails or power-driven anchors at 600 mm (24 inches) OC. Anchor runner channels to coiling grid, where applicable, with stove bolts. Where studs extend above ceiling system, install headers where required to receive runners.
30. Studs: Position studs vertically in runners. Where studs are located adjacent to openings or partition intersections and comers. anchor studs to runners with manufacturer's metal lock fastener or with 13 mm (1/2 inch) Type S pan-head screws.
    a. Space studs at 400 mm (16 Inches) and 600 mm (24 inches) OC as indicated or scheduled.
        1) Cementitious Backer Units (CBU): Space studs at maximum of 400 mm (16 inches) OC.
        2) Limiting Heights: Comply with ASTM C 754 for transverse load of 240 Pa (5 lb-force/SF) without exceeding either allowable stress or deflection of L/240. Comers and Intersections: Locate studs no more than 50 mm (2 inches) from abutting partitions, comers, etc.
    b. Openings: Locate studs not more than 50 mm (2 inches) from opening frames. Anchor studs to frame anchor clips by bolt or screw attachment. Install headers over openings as recommended by the manufacturer.
        1) Solid-Core Wood Doors and Hollow Metal Doors: Provide two full-height studs at jambs fastened together back to back.
        2) Fire-Rated Openings: Comply with GA 219.
31. Bracing: Provide diagonal bracing at head of studs that terminate above the ceiling level. Bracing shall consist of metal studs bent to V-shape and extending at 45 degrees from partition head to structure above. Locate bracing 1 200 mm (48 inches) maximum OC.
32. Wood Blocking or Metal Reinforcement:
    a. Wood Blocking: See Division 6 Section "Rough Carpentry."
    b. Install metal reinforcement of size required for support of toilet and bath accessories, hardware, cabinets, shelving, counters, and other wall-mounted items.
    c. Set true to line, level, or plumb well-secured in stud wall and flush with back of drywall or other wall finish.
    d. Coordinate exact locations with other sections.

Miscellaneous Framing And Furring

33. General: Provide necessary framing and furring for special framing at recesses, offsets, specialty Items, and at wall-mounted casework, shelving, and equipment.
34. Furring Channels: Install furring channels over back-up material. Position channels vertically at 600 mm (24 inches) OC. Use power-activated fasteners or stub nails at 600 mm (24 Inches) OC along alternating flanges. Shim channels level as required.
    a. Cementitious Backer Units (CBU): Space furring at maximum of 400 mm (16 inches) OC.

35. Resilient Furring Channels: Screw-attach In accordance with manufacturer's recommendations.
    a. Spacing: 600 mm (24 inches) OC for framing at 16 inches OC and 400 mm (16 inches) OC for framing at 24 Inches OC.

Ceiling Grillage Erection

36. Reference Standard: Erect steel framing In accordance with ASTM C 754.
37. Hangers: Install wire hangers spaced not over 1 200 mm (48 inches) OC in direction of 38 mm (1-1/2 inch) main runner channels and within 150 mm (6 inches) of ends of main runners or interruptions of ceiling continuity. Hang from structure above.
38. Runners: Place main runners not over 1 200 mm (48 inches) OC. Provide, position, and level hangers with hangers saddle-tied along runners. Space furring channels at 600 mm (24 inches) OC at right angles to runner channels and secure with furring channel clips.
39. Reinforcement: At light troffers or other openings, reinforce grillage with 19 mm (314 inch) cold-rolled channels wired atop and parallel to main runner channels.
    a. Provide lateral seismic bracing as required by code.
40. Special Shapes: Provide necessary framing and suspension for off sets, verticals, etc.

Insulation

41. Sound Insulation: Place sound Insulation blankets in partitions tight within spaces, around cut openings. behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
    a. Ductwork Penetrations: Provide one-inch wide clearance around ductwork and pack with fiberglass ready for joint sealers.

Installation Of Gypsum Drywall

42. Reference Standards: Apply and finish gypsum board in accordance with GA 216 and ASTM C 840.
43. Partition Gypsum Board Layout: Apply gypsum wallboard panels vertically with abutting ends and edges occurring over stud flanges or furring.
    a. Joints on Opposite Sides of Partitions: Stagger; joints shall not occur over same stud.
    b. Two Layer Construction: Stagger Joints between layers.
44. Ceiling Gypsum Board: Apply gypsum board of maximum practical length with long dimensions at right angles to furring channels. End and edge joints shall occur over furring channels with end joints staggered. Properly support gypsum board around cutouts and openings.
45. Fasteners: Apply board to studs or furring with drywall screws spaced 300 mm (12 inches) OC in field of board and 200 mm (8 inches) OC staggered along abutting edges.
46. Water-Resistant: Apply gypsum wallboard manufacturer's recommended sealant to raw cut edges and screw heads.
47. Cementitious Backer Units (CBU): Install in accordance with ANSI A108.11 and manufacturer's recommendations.
48. Accessories:
    a. Comer Bead: Apply as recommended by manufacturer at exposed outer corners.
    b. Trim (Casing Beads): Apply as recomrnended by manufacturer, where gypsum board abuts other materials, and as indicated.
    c. Control Joints: Comply with GA 216.
        1) Walls: Install at not more than 9 m (30 feet) OC.
        2) Ceilings: Install at not more than 15 m (50 feet) OC and where framing changes direction.
        3) Coordinate locations with the Owner.
49. Access Panels: Securely install access panels furnished under other sections. Set plumb and square to align with finish surface.

50. Acoustical Sealant: Seal perimeter and penetrations on both sides of sound-rated partitions and partitions with sound-attenuation blankets with minimum of single 6 mm (1/4 inch) bead of sealant
    a. Locations:
        1) Seal around gypsum-board perimeter in angle formed by gypsum-board panels and abutting dissimilar materials.
        2) Seal intersections of gypsum board with dissimilar materials.
        3) Seal pipe. conduit, ductwork, penetrations, etc.
        4) Seal around cutouts for lights, cabinets, pipes, ductwork, electrical boxes, etc.
        5) Seal gypsum board panel terminations in door and window frames.
        6) Seal control-joint locations before installing control Joints to panels.
    b. Installation: Comply with ASTM C 919 and requirements of indicated sound-rated assembly. Provide number and positions of beads to comply with sound rating of assembly.
51. Tolerances: Gypsum-board surface plane within plus or minus 3 mm in 3 000 mm (1/8 inch in 10 feet).
52. Finishing: Finish in accordance with GA 214.
    a. Concealed Locations (Not Exposed to View in Rooms): Level 1
    b. Beneath Tile: Level 2.
    c. Other Finished Areas: Level 4. Finish joints, trim, and fastener dimples. Sand smooth.
    d. Cementitious Backer Units (CBU): Treat joints in accordance with ANSI A108.11 and manufacturer's recommendations.

END OF SECTION 09 01 20 00

SECTION 09 01 20 91 - PLASTER RESTORATION

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of materials for lath and plaster renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Quality Assurance

2. Regulatory Requirements:
   a. Plaster Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
   b. Plaster Floor/Ceilings and Roof/Ceiling Assemblies: Listed and labeled for fire-protective ratings as indicated or scheduled.
   c. Fire Rated Assemblies: Comply with UL 05, FM P8016, or GA 600 for required fire-rated assembly.

Submittals

3. Product Data: Submit in accordance with Detailed Scope of Work. Include each type of plaster material, metal lath. and lathing accessories to be installed.

Delivery, Storage, And Handling

4. General:
   a. Plastering Materials: Deliver in original unopened containers and store off ground and under cover.
   b. Metal Lath and Accessories: Protect from rusting during storage.
   c. Rusted or Water Damaged Materials: Subject to rejection before or after installation.

Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
   a. Cold-Weather Protection: Do not apply plaster if ambient temperature is less than 4 degrees C (40 degrees F) or more than 26 degrees C (80 degrees F). Maintain this temperature range in all areas 7 days prior to application, during application, and for 7 days after plaster is set.
   b. Hot-Weather Protection: Protect plaster against uneven or excessive evaporation during dry, hot weather and from strong blasts of dry air, either natural or artificial.
   c. Ventilation: Ventilate building spaces as required to remove water in excess of that required for hydration of plaster. Begin ventilation immediately after plaster is applied and continue until it sets.
6. Existing Conditions: See Division 1 Section “Summary of Work”. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
7. Protection: Protect grounds, plantings, buildings, and any other facilities or property from damage caused by construction operations.

Scheduling And Sequencing

8. Scheduling and Completion: Comply with Detailed Scope of Work.
   a. Sequence plaster application with installation and protection of other work so that neither will be damaged by installation of other.

PRODUCTS

Materials

9. Materials for Patching, Extending, and Matching:
    a. Provide same products or types of construction as existing structure, as needed to patch, extend, or match existing work.
        1) Generally, Contract Documents will not define products or standards of workmanship present in existing construction. Determine products by inspection and any necessary testing, and workmanship by use of existing as sample of comparison.
        2) Patching, extending, and matching of existing work and systems shall result in complete, finished system.
    b. Presence of product, finish, or type of construction, requires that patching, extending, or matching shall be performed as necessary to make work complete and consistent.
10. Partition Metals: ASTM C 645, galvanized steel:
    a. Interior Steel Studs: Minimum 0.46 mm (25 gage), provide sizes and gages to match existing, or as indicated.
        1) Provide minimum of 0.84 mm (20 gage) studs both sides of hollow metal frames.
    b. Steel Stud Runners: Match studs. Provide long leg runners for slip joint at structure above to allow for deflection.
    c. Furring Channels: Hat-shaped furring channels, minimum 0.46 mm (25 gage).
    d. Sheet Metal Reinforcement (Alternate to Wood Blocking): 1.52 mm (16 gage) minimum.
11. Suspended Ceiling Metals:
    a. Main Runners (Primary Members): ASTM C 754 cold-rolled steel channels with rust-inhibitive finish.
        1) 50 mm (2 inches) deep, 88 kg per 100 m (590 pounds per 1,000 LF).
        2) 38 mm (1-1/2 inch) deep, 70 kg per 100 m (475 pounds per 1,000 LF).
        3) 19 mm (3/4 inch) deep, 45 kg per 100 m (300 pounds per 1,000 LF).
    b. Cross Furring (Furring Channels): Hat-shaped galvanized steel furring channels, minimum 0.46 mm (25 gage).
    c. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
        1) Hanger Wire: Minimum 4.1 mm (8 gage).
        2) Tie Wire: 6 mm (16 gage).
12. Lath:
    a. Metal Lath: ASTM C 847, galvanized expanded metal.
        1) Weight: In compliance with ASTM C 841 for conditions and spacing of supports.
    b. Gypsum Lath: ASTM C 37, plain. Provide Type X at fire-rated assemblies.
        1) Thickness: As indicated or specified and in compliance with ASTM C 841 for conditions and spacing of supports.
13. Fasteners:
    a. Screws: ASTM C 1002, corrosion-resistant. Provide types as recommended by manufacturer for each application.
        1) To Metal Framing: Minimum 25 mm (1 inch), Type S.
        2) To Wood Framing: Minimum 32 mm (1-1/4 inch), Type W bugle head.
14. Accessories: ASTM C 841, galvanized steel.
    a. Comer Beads: Small nose with expanded flanges, unless otherwise indicated.
    b. Casing Beads: Square-edged style. with short or expanded flanges to suit kinds of plaster bases indicated.
    c. Control Joints: Prefabricated folded pair of non-perforated screeds in M-shaped configuration, with expanded or perforated flanges.
        1) Provide removable protective tape on plaster face of control joints.
    d. Cornerite: Galvanized expanded metal lath in accordance with ASTM C 841.
15. Gypsum Plaster Materials: ASTM C 28.
    a. Base Coat Plasters: One of following:
        1) Gypsum ready-mixed plaster with mill-mixed perlite aggregate.
        2) Gypsum wood-fibered plaster, ASTM C 28, Type N.
    b. Finish Coat Plasters: One of following:

1) Gypsum ready-mixed finished plaster, manufacturers standard mill-mixed gauged interior finish.
2) Gypsum Gauging Plaster: ASTM C 28, Type G.

c. Quicklime: ASTM C 5.
d. Sand: ASTM C 35.
e. Finishing Hydrated Limes: ASTM C 206, Type S, special hydrated lime for finishing purposes.
f. Bonding Compound for Gypsum Plaster: ASTM C 631.
g. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or substances that may be deleterious to plaster or metals in contact with plaster.

16. Sound-Isolation Materials:
    a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral-fiber blankets, 12 to 16 kg per cu m (0.75 to 1 PCF), thickness as indicated or scheduled, or required by fire-rated assembly.
    b. Acoustical Sealant:
        1) Concealed: ASTM C 919 nondrying, non-hardening, non-skinning, non-bleeding, and non-staining.
        2) Exposed: ASTM C 919 non-oxidizing and skinning, permanently elastic, and paintable.
    c. Ductwork Penetrations Packing: Low-density fiberglass.
17. Gypsum Plaster Mixes: As recommended by manufacturer:
    a. Scratch Coat:
        1) Over Metal Lath: Gypsum wood-fibered plaster, neat or with job-mixed sand.
        2) Over Gypsum Lath: Gypsum neat plaster with job-mixed sand.
        3) Over Unit Masonry: Gypsum wood-fibered plaster, neat or with job-mixed sand.
    b. Brown Coat:
        1) Over Metal Lath: Gypsum wood-fibered plaster, with job-mixed sand.
        2) Over Gypsum Lath: Gypsum neat plaster with job-mixed sand.
        3) Over Unit Masonry: Gypsum wood-fibered plaster with job-mixed sand.
    c. Finish Coat: Proportion materials for finish coats to comply with ASTM C 842 for each type of finish coat and texture indicated.
        1) Gypsum Gauging Plaster 1 part plaster and 2 parts lime.
            a) Over lightweight aggregate base coats, add 15 L (1/2 cubic foot) of perlite fines or 23 kg (50 pounds) of No. 1 white silica sand per 45 kg (100 pounds) of plaster.
        2) Gypsum Ready-mixed Finish Plaster Neat.
    d. Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

EXECUTION

Examination

18. Units, Spaces, and Areas to be renovated: Comply with Detailed Scope of Work.
    a. Verify that surfaces to receive rough carpentry are prepared to required grades and dimensions.

Preparation

19. Dust Protection: Comply with Detailed Scope of Work.
20. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
21. Protection: Comply with Detailed Scope of Work.
    a. Protection: Provide drapes and drop cloths necessary to protect walls, floors, ductwork and piping, electrical work, etc. during plastering operations.
22. Selective Demolition: Comply with Detailed Scope of Work.

23. Surface Preparation: Clean projections, dust, loose particles, grease, bond breakers, and foreign matter from surfaces to receive plaster.
    a. Do not apply plaster directly to surfaces (1) of masonry or concrete that have been coated with bituminous compound or other waterproofing agents, or (2) that have been painted or previously plastered.
    b. Before plaster work is started, wet masonry and concrete surfaces thoroughly with fine fog spray of clean water to produce uniformly moist surface.
    c. Do not apply plaster to surfaces containing frost.

Laying-Out Work

24. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
    a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
    b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner for adjustment before work affected is performed.
        1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
25. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

Performance

26. Patching: Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship.
    a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
27. Damaged Surfaces: Comply with Detailed Scope of Work.
28. Transitions from Existing to New Work: Comply with Detailed Scope of Work.
29. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall work abuts overhead structure, isolate work from structural movement sufficiently to prevent transfer of loads to work from building structure. Install slip or cushion-type joints to absorb deflections but maintain lateral support.
    a. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

Installation Of Suspended Steel Framing

30. General: Construct ceilings of lath and plaster on suspended steel framing system in accordance with manufacturer's recommendations and Reference Standards.
31. Hanger Installation: Attach hangers to structure above ceiling to comply with NAAMM ML/SFA 920.
32. Ceiling Suspension System Components: Install In sizes and at spacings indicated but not in smaller sizes or greater spacings than those required by ASTM C 841 and NAAMM ML/SFA 920.
    a. Wire Hangers: Space and install wire hangers In accordance with ASTM C 841 and within 150 mm (6 inches) of channel ends, unless closer spacing indicated or required for fire-resistance rated assembly.
    b. Main Runners (Primary Members): Space and install channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
    c. Cross Furring (Furring Channels): Space and install furring channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
33. Framing Around Openings: Frame channels and lath on suspended soffits and ceilings and at furring to receive electric lights, etc. as indicated or as necessary to complete work. Furnish and install in furring, plaster rings or access panels furnished under other sections.

Installation Of Steel Stud Partitions

34. General: Install steel stud partition support systems in accordance with manufacturer's recommendations and Reference Standards.
35. Steel Stud Systems: Comply with ASTM C 754.
    a. To Receive Metal Lath: Space studs in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space studs in accordance with ASTM C 841.
36. Extend partition support systems to finish ceilings and attach to ceiling suspension members, unless otherwise indicated.

Metal Furring

37. General: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, bath accessories, furnishings, and similar work to comply with manufacturer’s recommendations.
38. Metal Furring to Receive Gypsum Lath: Space furring channels in accordance with ASTM C 841.
39. Metal Furring Systems:
    a. To Receive Metal Lath: Space furring in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space furring in accordance with ASTM C 841.
40. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall work abuts overhead structure, isolate work from structural movement sufficiently to prevent transfer of loads to work from building structure. Install slip or cushion-type joints to absorb deflections but maintain lateral support.
    a. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

Installation Of Suspended Steel Framing

41. General: Construct ceilings of lath and plaster on suspended steel framing system in accordance with manufacturer’s recommendations and Reference Standards.
42. Hanger Installation: Attach hangers to structure above ceiling to comply with NAAMM ML/SFA 920.
43. Ceiling Suspension System Components: Install In sizes and at spacings indicated but not in smaller sizes or greater spacings than those required by ASTM C 841 and NAAMM ML/SFA 920.
    a. Wire Hangers: Space and install wire hangers in accordance with ASTM C 841 and within 150 mm (6 inches) of channel ends, unless closer spacing indicated or required for fire-resistance rated assembly.
    b. Main Runners (Primary Members): Space and install channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
    c. Cross Furring (Furring Channels): Space and install furring channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
44. Framing Around Openings: Frame channels and lath on suspended soffits and ceilings and at furring to receive electric lights, etc. as indicated or as necessary to complete work. Furnish and install in furring, plaster rings or access panels furnished under other sections.

Installation Of Steel Stud Partitions

45. General: Install steel stud partition support systems in accordance with manufacturer's recommendations and Reference Standards.
46. Steel Stud Systems: Comply with ASTM C 754.
    a. To Receive Metal Lath: Space studs in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space studs in accordance with ASTM C 841.
47. Extend partition support systems to finish ceilings and attach to ceiling suspension members, unless otherwise indicated.

Metal Furring

48. General: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, bath accessories, furnishings, and similar work to comply with manufacturer's recommendations.
49. Metal Furring to Receive Gypsum Lath: Space furring channels in accordance with ASTM C 841.
50. Metal Furring Systems:
    a. To Receive Metal Lath: Space furring in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    b. To Receive Gypsum Lath: Space furring in accordance with ASTM C 841.

Lathing

51. Metal Lathing: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
    a. At Metal Framing: Attach metal lath to furring channels with long dimension of sheet at right angles to furring channels with gage wire ties spaced not over 150 mm (6 inches) apart.
    b. At Wood Framing: Nail metal lath to wood framing with long dimension of sheet at right angles to framing member.
    c. Place ties where sides of sheets laps at supports and at side laps of sheets between supports. Lap metal lath not less than 13 mm (112 inch) at sides of sheets and 25 mm (1 inch) at ends of sheets.
    d. Suspended and Furred Ceilings: Use 1.8 kg/sq m (3.4 pounds/SY) minimum weight diamond mesh lath.
    e. Ceramic Tile Setting Beds: Use 1.8 kg/sq m (3.4 pounds/SY) minimum weight diamond mesh lath.
52. Gypsum Lath: Install in accordance with ASTM C 841.
    a. Wood Framing and Furrlng: Install lath as follows:
        1) With screws to comply with lath manufacturer's directions.
        2) With nails.
        3) Provide floating angle construction.
    b. Suspended and Furred Ceilings: Install lath to furring members with clips.
    c. Vertical Metal Framing and Furring: Install lath as follows:
        1) With screws.
        2) With clips, supplemented by screws where required by lath manufacturer.
        3) Where sound-rated partitions are indicated, attach lath with resilient clips.

Installation Of Accessories

53. Accessories: Install as required to repair area of work to match existing. Install in accordance with ASTM C 841. Miter or cope accessories at comers; Install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories In place and alignment during plastering.
54. Interior Corners: Apply cornerite.
55. Corner Beads: Install corner beads tightly secured to lath at exposed exterior corners.
56. Casing Beads: Install at terminations of plaster work, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or metal frames act as casing beads.
57. Control Joints: Install at locations indicated or, if not indicated, at spacings and locations required by Reference Standards. Coordinate specific locations with the Owner.
58. Access Panels: Provide access panels as required for maintenance of concealed plumbing work in coordination with Division 15 Section "Plumbing." Tiled Areas: Coordinate with Division 9 Section "Ceramic Tile."
59. Sound-Rated Plaster Work: Where sound-rated plaster work is indicated by STC ratings or other notation:
    a. Acoustical Sealant: Seal work at perimeters, control joints, openings, and penetrations with continuous bead of acoustical sealant. Comply with ASTM C 919 and plastering manufacturer's recommendations for location of sealant beads.

b. Sound Insulation: Install insulation blankets within stud cavities of sound-rated partition assemblies where incated.

Plastering

60. Plastering: Comply with ASTM C 842 in thickness to match existing.
    a. Preparation: Remove loose, fractured, or separated plaster to face of substrate. repairing lath at substrate to ensure repair area bounded by solid and sound existing plaster construction.
        1) Prepare monolithic surfaces for bonded base coats and use bonding compound to comply with Reference Standards for conditioning of monolithic surfaces.
    b. Grout hollow metal frames, bases, and similar work with base-mat plaster material, and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 150 mm (6 inches) at each jamb anchor dip.
    c. Plaster flush with metal frames and other built-in metal items or accessories that act as plaster ground, unless otherwise indicated. Where plaster is not terminated at metal by casing beads, cut base coat free from metal before plaster sets and groove finish coat at junctures with metal.
61. Preparation: Check metal grounds, comer beads, screeds, and other accessories carefully for alignment before starting plaster application. Check expansion and control joints and supporting metal structures to ensure that expansion and control joints can move unrestrained.
62. Plaster: Apply In accordance with ASTM C 842 in thickness to match existing:
    a. Use three-coat work over following plaster bases:
        1) Metal lath.
        2) Gypsum lath attached to ceiling supports by clips.
        3) Gypsum lath attached to ceiling supports spaced over 400 mm (16 inches) OC.
        4) Gypsum lath, 9.5 mm (3/8 inch) thick, with separate vapor retarder behind.
    b. Use two-coat work over following bases.
        1) Gypsum lath except for installations requiring three-coat work.
        2) Unit masonry.
        3) Concrete, cast-in-place or precast when surface condition complies with ASTM C 842 for plaster bonded to solid base.
    c. First Coat: Apply first coat of plaster with such force to secure good key.
    d. Finish Coats: Apply troweled finish coats unless otherwise indicated.
63. Workmanship: Perform work true to line, straight, and plumb.
    a. Finished Surfaces: Free from waves, dents, bumps, cracks, pits. checks, streaks, catfaces, blisters, or other defects. Cutout and property replace defective areas.
    b. Execute work to avoid any irregularity occurring at point or place where one section is joined to another.
    c. Arises and Angles: True and sharp.
64. Tolerances: Plaster surface plane within plus/minus 3 mm in 3 000 mm (1/8 inch in 10 feet).

Integrating Existing Work

65. Protection: Comply with Detailed Scope of Work.

Adjustments

66. Partition Removal: Comply with Detailed Scope of Work.

Dust Control

67. Dust: Comply with Detailed Scope of Work.

Patching And Cleaning

68. Cutting and Patching: Do necessary cutting, patching, and repairing and pointing up of plastering after other work is in place to restore defective areas. Repair or replace work to eliminate blisters, buckles, excessive crazing and check-cracking, dry outs, efflorescence, sweat-outs, and similar defects and where bond to substrate has failed.
    a. Sand smooth-troweled finishes lightly to remove trowel marks and arises.

69. Cleaning: As rapidly as plastering is completed in each space, clean up rubbish, utensils, and surplus material, sweep floor and leave in neat condition for work of others.
    a. When general plastering is concluded, remove plastering rubbish, equipment, and surplus materials from premises.
    b. Clean surfaces splattered with plaster.

END OF SECTION 09 01 20 91

Task	Specification	Specification Description
09 01 20 91	09 01 20 00	Gypsum Board Renovation

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SECTION 09 01 30 91 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Quarry tiles.
2. Pressed floor tiles.
3. Porcelain tiles.
4. Ceramic mosaic tiles.
5. Glazed wall tiles.
6. Thresholds.
7. Tile backing panels.
8. Waterproof membranes.
9. Crack isolation membranes.
10. Setting materials.
11. Grout materials.
12. Metal flooring transitions.
13. Metal edge trim.

B. Related Requirements:

1. [**Section 071326 "Self-Adhering Sheet Waterproofing"**][**Section 071353 "Elastomeric Sheet Waterproofing"**][**Section 071354 "Thermoplastic Sheet Waterproofing"**][**Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"**][**Section 071416 "Cold Fluid-Applied Waterproofing"**] for waterproofing under thickset mortar beds.
2. Section 079200 "Joint Sealants" for sealing of movement joints in tile surfaces.
3. Section 092400 "Cement Plastering" for scratch coat for thickset mortar setting-bed installations.
4. Section 092613 "Gypsum Veneer Plastering" for cementitious backer units.
5. Section 092900 "Gypsum Board" for tile backing panels.
6. Section 093023 "Glass Tiling."
7. Section 093033 "Stone Tiling."
8. Section 096340 "Stone Flooring" for stone thresholds.

1.2 DEFINITIONS

A. General: Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. Face Size: Actual tile size, excluding spacer lugs.

C. Large Format Tile: Tile with at least one edge **15 inches (381 mm)** or longer.

D. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**]<**Insert**

location> .

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Shop Drawings: Show locations, plans, and elevations, of each type of tile and tile pattern. Show widths, details, and locations of movement joints in tile substrates and finished tile surfaces. [**Show thresholds.**]

C. Samples for Initial Selection: For tile, grout, and accessories involving color selection or shade variation.

D. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required. [**For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.**][**For tile with aesthetic classification V3 or V4, provide 12 tiles from same production run.**]
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least [**12 inches (300 mm) square**][**36 inches (900 mm) square**]<**Insert size**> , but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
3. Full-size units of each type of trim and accessory [**for each color and finish required**] .
4. Stone thresholds in **6-inch (152-mm)** lengths.
5. Metal flooring transitions **6-inch (152-mm)** lengths.

E. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration (HPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Product Data: For adhesives, indicating VOC content.
13. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

B. Product Certificates: For each type of product, including product use classification.

C. Product Test Reports:

1. Tile-setting and -grouting products.
2. Certified porcelain tile.

D. Slip-Resistance Test Reports: For each type of floor tile, from a qualified independent testing agency.

E. Field Quality Control Reports: Water test reports of membrane in wet areas.

F. Qualification Statements: For Installer.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to [**3**][**5**]<**Insert number**> percent of amount installed for each type, composition, color, pattern, and size specified.
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated for Project.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is [**a Five-Star member of the National Tile Contractors Association**][**or**][**a Trowel of Excellence member of the Tile Contractors' Association of America**] .
2. Installer's supervisor for Project holds the International Masonry Institute's Supervisor Certification.
3. Installer employs only [**Ceramic Tile Education Foundation Certified Installers**][**or**][**installers recognized by the U.S. Department of Labor as Journeyman Tile Layers**] for Project.
4. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of [**mud floors**][**mud walls**][**membranes**][**shower receptors**][**and**][**large format tile**] .

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of [**each type of**] floor tile installation.
2. Build mockup of [**each type of**] wall tile installation.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.11 WARRANTY

A. System Warranty: Manufacturer's non-prorated comprehensive warranty that agrees to repair and replace defective installation areas, material, and labor that fail under normal usage within specified warranty period.

1. Warranty Period: [**Five years**][**10 years**][**25 years**][**Lifetime**] from date of Product Purchase.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Tile: Obtain [**tile of each type and color or finish**][**tile of each type**][**tile of each color or finish**][**tile**] from single source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Tiling System: Obtain system products from single manufacturer and each aggregate from single source or producer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Custom Building Products**]
c. [**Laticrete International, Inc.**]
d. [**MAPEI Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]

b. [**Custom Building Products**]
c. [**Laticrete International, Inc.**]
d. [**MAPEI Corporation**]
e. <**Insert manufacturer's name**>

3. Obtain setting and grouting materials, except for unmodified portland cement and aggregate, from single manufacturer.
4. Obtain underlayment from manufacturer of setting and grouting materials.
5. Obtain waterproof membrane, crack isolation, and other required membranes from manufacturer of setting and grouting materials.
6. Obtain joint sealants from manufacturer of setting and grouting materials.

C. Accessory Products: Obtain each of the following products specified in this Section from a single manufacturer:

1. Stone thresholds.
2. Backer units.

2.2 CERAMIC TILE SYSTEM, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard Grade requirements [**unless otherwise indicated**] .

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation [**in swimming pools**][**on exteriors**][**or**][**in wet areas**] , do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.3 QUARRY TILES

A. Quarry Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Olean; a brand of Dal-Tile Corporation**]
b. [**Daltile; a brand of Dal-Tile Corporation**]
c. [**Elgin Butler Company**]
d. [**Florida Tile, Inc.**]
e. [**Interceramic**]
f. [**Metropolitan Ceramics**]
g. [**Quarry Tile Company.**]
h. [**Summitville Tiles, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Olean; a brand of Dal-Tile Corporation**]
b. [**Daltile; a brand of Dal-Tile Corporation**]
c. [**Elgin Butler Company**]
d. [**Florida Tile, Inc.**]
e. [**Interceramic**]
f. [**Metropolitan Ceramics**]
g. [**Quarry Tile Company.**]
h. [**Summitville Tiles, Inc.**]
i. <**Insert manufacturer's name**>

3. Type: [**Unglazed**][**Glazed**][**Chemical resistant**] .
4. Face Size: [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**][**6 by 3 inches (152 by 76 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 3-7/8 inches (200 by 98 mm)**][**8 by 8 inches (200 by 200 mm)**]<**Insert dimensions**> .
5. Thickness: [**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**][**3/4 inch (19 mm)**] .
6. Wearing Surface: [**Nonabrasive, smooth**][**Abrasive aggregate embedded in surface**]<**Insert description**> .
7. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**] .
8. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.

a. Chemical Reagent: <**Insert chemical reagent**> .

9. Tile Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and pattern**> .
10. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**> .
11. Precoat with temporary protective coating.
12. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

a. Base: Coved [**with surface bullnose top edge**] , face size [**6 by 6 inches (152 by 152 mm)**][**8 by 3-7/8 inches (200 by 98 mm)**]<**Insert dimensions**> .
b. Wainscot Cap: Surface bullnose, face size [**6 by 6 inches (152 by 152 mm)**][**8 by 3-7/8 inches (200 by 98 mm)**]<**Insert dimensions**> .
c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.

2.4 PRESSED FLOOR TILES

A. Pressed Floor Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Olean; a brand of Dal-Tile Corporation**]
   b. [**Daltile; a brand of Dal-Tile Corporation**]
   c. [**Florim USA**]
   d. [**Interceramic**]
   e. [**Marazzi USA; a brand of Dal-Tile Corporation**]
   f. [**Vitromex USA, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Olean; a brand of Dal-Tile Corporation**]
   b. [**Daltile; a brand of Dal-Tile Corporation**]
   c. [**Florim USA**]
   d. [**Interceramic**]
   e. [**Marazzi USA; a brand of Dal-Tile Corporation**]
   f. [**Vitromex USA, Inc.**]
   g. <**Insert manufacturer's name**>

3. Type: [**Unglazed**][**Glazed**][**Chemical resistant**] .
4. Face Size: [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**7-3/4 by 3-7/8 inches (197 by 98 mm)**][**7-7/8 by 7-7/8 inches (200 by 200 mm)**][**11-13/16 by 11-13/16 inches (300 by 300 mm)**]<**Insert dimensions**> .
5. Face Size Variation: [**Calibrated or rectified**][**Rectified**] .
6. Thickness: [**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**] .
7. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**] .
8. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.

   a. Chemical Reagent: <**Insert chemical reagent**> .

9. Tile Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and pattern**> .
10. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**> .
11. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base: Coved, module size [**same as adjoining flat tile**]<**Insert size**> .
    b. Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size [**same as adjoining flat tile**]<**Insert size**> .
    c. Base Cap for Thinset Mortar Installations: Surface bullnose, module size [**same as adjoining flat tile**]<**Insert size**> .

d. Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size [**same as adjoining flat tile**]<**Insert size**> .
e. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size [**same as adjoining flat tile**]<**Insert size**> .
f. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
g. External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size [**same as adjoining flat tile**]<**Insert size**> .
h. External Corners for Thinset Mortar Installations: Surface bullnose, module size [**same as adjoining flat tile**]<**Insert size**> .
i. Internal Corners:

1) Coved, module size [**same as adjoining flat tile**]<**Insert size**> .
2) Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

j. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from **1/2 to 1/4 inch (12.7 to 6.4 mm)** across nominal **4-inch (102-mm)** dimension.

2.5 PORCELAIN TILES

A. Porcelain Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Olean; a brand of Dal-Tile Corporation**]
b. [**Crossville, Inc.**]
c. [**Daltile; a brand of Dal-Tile Corporation**]
d. [**Florida Tile, Inc.**]
e. [**Florim USA**]
f. [**Interceramic**]
g. [**Iris Ceramics U.S., a division of Stonepeak Ceramics, Inc.**]
h. [**Marazzi USA; a brand of Dal-Tile Corporation**]
i. [**Portobello America, Inc.**]
j. [**Vitromex USA, Inc.**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Olean; a brand of Dal-Tile Corporation**]
b. [**Crossville, Inc.**]
c. [**Daltile; a brand of Dal-Tile Corporation**]
d. [**Florida Tile, Inc.**]
e. [**Florim USA**]
f. [**Interceramic**]
g. [**Iris Ceramics U.S., a division of Stonepeak Ceramics, Inc.**]
h. [**Marazzi USA; a brand of Dal-Tile Corporation**]
i. [**Portobello America, Inc.**]

j. [**Vitromex USA, Inc.**]
k. <**Insert manufacturer's name**>

3. Type: [**Unglazed**][**Glazed**][**Chemical resistant**] .
4. Certification: Tile certified by the Porcelain Tile Certification Agency.
5. Face Size: [**3 by 3 inches (76 by 76 mm)**][**4 by 4 inches (102 by 102 mm)**][**6 by 6 inches (152 by 152 mm)**][**7-3/4 by 3-7/8 inches (197 by 98 mm)**][**7-7/8 by 7-7/8 inches (200 by 200 mm)**][**11-13/16 by 11-13/16 inches (300 by 300 mm)**]<**Insert dimensions**> .
6. Face Size Variation: Rectified.
7. Thickness: [**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**] .
8. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**] .
9. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.

   a. Chemical Reagent: <**Insert chemical reagent**> .

10. Tile Color, Glaze, and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color, glaze, and pattern**> .
11. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**> .
12. Precoat with temporary protective coating.
13. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base Cap: Surface bullnose, module size [**same as adjoining flat tile**]<**Insert size**> .
    b. Wainscot Cap: Surface bullnose, module size [**same as adjoining flat tile**]<**Insert size**> .
    c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
    d. External Corners: Surface bullnose, module size [**same as adjoining flat tile**]<**Insert size**> .
    e. Internal Corners: Field-butted square corners.
    f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from **1/2 to 1/4 inch (12.7 to 6.4 mm)** across nominal **4-inch (102-mm)** dimension.

2.6 CERAMIC MOSAIC TILES

A. Ceramic Mosaic Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Olean; a brand of Dal-Tile Corporation**]
   b. [**Crossville, Inc.**]
   c. [**Daltile; a brand of Dal-Tile Corporation**]
   d. [**Jeffrey Court Inc.**]
   e. [**Marazzi USA; a brand of Dal-Tile Corporation**]
   f. [**Portobello America, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Olean; a brand of Dal-Tile Corporation**]
    b. [**Crossville, Inc.**]
    c. [**Daltile; a brand of Dal-Tile Corporation**]
    d. [**Jeffrey Court Inc.**]
    e. [**Marazzi USA; a brand of Dal-Tile Corporation**]
    f. [**Portobello America, Inc.**]
    g. <**Insert manufacturer's name**>

3. Type: [**Unglazed**][**Glazed**][**Chemical resistant**] .
4. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
5. Module Face Size: [**1 by 1 inch (25.4 by 25.4 mm)**][**1 by 2 inches (25.4 by 50.8 mm)**][**2 by 2 inches (50.8 by 50.8 mm)**]<**Insert dimensions**> .
6. Thickness: **1/4 inch (6.4 mm)**.
7. Face: [**Plain**][**Pattern of design indicated,**] with cushion edges.
8. Surface: [**Smooth, without**][**Slip resistant, with**] abrasive admixture.
9. Product Use Classification: [**Interior, Dry (ID)**][**Interior, Wet (IW)**][**Interior, Wet Plus (IW+)**][**Exterior, Wet (EW)**][**Oil/Greases (O/G)**] .
10. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.

    a. Chemical Reagent: <**Insert chemical reagent**> .

11. Tile Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and pattern**> .
12. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**> .
13. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base: Coved, module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**]<**Insert dimensions**> .
    b. Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**]<**Insert dimensions**> .
    c. Base Cap for Thinset Mortar Installations: Surface bullnose, module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**][**2 by 2 inches (50.8 by 50.8 mm)**]<**Insert dimensions**> .
    d. Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**]<**Insert dimensions**> .
    e. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**][**2 by 2 inches (50.8 by 50.8 mm)**]<**Insert dimensions**> .
    f. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
    g. External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**]<**Insert dimensions**> .
    h. External Corners for Thinset Mortar Installations: Surface bullnose, module size [**1 by 1 inch (25.4 by 25.4 mm)**][**2 by 1 inch (50.8 by 25.4 mm)**][**2 by 2 inches (50.8 by 50.8 mm)**]<**Insert dimensions**> .
    i. Internal Corners:

1) Coved: Module size [1 by 1 inch (25.4 by 25.4 mm)][2 by 1 inch (50.8 by 25.4 mm)]<**Insert dimensions**> .
2) Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

j. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (102-mm) dimension.

2.7 GLAZED WALL TILES

A. Glazed Wall Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Olean; a brand of Dal-Tile Corporation**]
   b. [**Crossville, Inc.**]
   c. [**Daltile; a brand of Dal-Tile Corporation**]
   d. [**Interceramic**]
   e. [**Jeffrey Court Inc.**]
   f. [**Marazzi USA; a brand of Dal-Tile Corporation**]
   g. [**Vitromex USA, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Olean; a brand of Dal-Tile Corporation**]
   b. [**Crossville, Inc.**]
   c. [**Daltile; a brand of Dal-Tile Corporation**]
   d. [**Interceramic**]
   e. [**Jeffrey Court Inc.**]
   f. [**Marazzi USA; a brand of Dal-Tile Corporation**]
   g. [**Vitromex USA, Inc.**]
   h. <**Insert manufacturer's name**>

3. Module Face Size: [4-1/4 by 4-1/4 inches (108 by 108 mm)][6 by 4-1/4 inches (152 by 108 mm)][6 by 6 inches (152 by 152 mm)]<**Insert dimensions**> .
4. Face Size Variation: Rectified.
5. Thickness: 5/16 inch (8 mm).
6. Tile Color and Pattern: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and pattern**> .
7. Grout Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**> .
8. Mounting: [**Loose tiles**][**Factory, back mounted**][**Pregrouted sheets of tile, factory assembled and grouted with manufacturer's standard white silicone rubber**] .
9. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable [**and matching characteristics of adjoining flat tile**] . Provide shapes as follows, selected from manufacturer's standard shapes:

a. Base for Portland Cement Mortar Installations: Coved, module size [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**][**6 by 3-3/4 inches (152 by 95 mm)**]<**Insert dimensions**> .
b. Base for Thinset Mortar Installations: Straight, module size [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**][**6 by 2 inches (152 by 50.8 mm)**]<**Insert dimensions**> .
c. Wainscot Cap for Portland Cement Mortar Installations: Bullnose cap, module size [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**][**6 by 2 inches (152 by 50.8 mm)**]<**Insert dimensions**> .
d. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size [**4-1/4 by 4-1/4 inches (108 by 108 mm)**][**6 by 6 inches (152 by 152 mm)**][**6 by 2 inches (152 by 50.8 mm)**]<**Insert dimensions**> .
e. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
f. External Corners for Portland Cement Mortar Installations: Bullnose shape with radius of at least **3/4 inch (19 mm)** unless otherwise indicated.
g. External Corners for Thinset Mortar Installations: Surface bullnose; same size as adjoining flat tile.
h. Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

B. Accessories: Provide vitreous china accessories of type and size indicated; suitable for installing by same method as used for adjoining wall tile.

1. One soap holder [**with grab handle**] for each shower and tub indicated.
2. One paper holder at each water closet.
3. Color and Finish: [**Match adjoining glazed wall tile**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**][**White, bright glaze**]<**Insert color and finish**> .

2.8 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Profile: Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to **1/16 inch (1.5 mm)** above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to **1/2 inch (12.7 mm)** or less above adjacent floor surface.

B. Granite Thresholds: ASTM C615/C615M.

1. Finish: [**Polished**][**Honed**]<**Insert finish**> .
2. Description:

a. Uniform, [**fine**][**medium**] -grained, [**white**][**gray**][**black**]<**Insert color**> stone without veining.
b. Match Architect's sample.
c. <**Insert name of variety**> provided by <**Insert producer, distributor, or importer**> .

C. Marble Thresholds: ASTM C503/C503M.

1. Finish: Honed.
2. Minimum Abrasion Resistance: [**10**][**12**] in accordance with ASTM C1353/C1353M or ASTM C241/C241M.

3. Description:

    a. Uniform, fine- to medium-grained white stone with gray veining.
    b. Match Architect's sample.
    c. <**Insert name of variety**> provided by <**Insert producer, distributor, or importer**> .

D. Slate Thresholds: ASTM C629/C629M, with fine, even grain.

1. Finish: Honed.
2. Classification: [**I Exterior**][**II Interior**] .
3. Description:

    a. Uniform, [**black**][**blue-black**][**gray**][**blue-gray**][**green**]<**Insert color**> stone [**and unfading**] .
    b. Match Architect's sample.
    c. <**Insert name of variety**> provided by <**Insert producer, distributor, or importer**> .

E. Solid-Surface Thresholds: Homogeneous-filled plastic resin complying with ISFA-02-01.

1. Type: Provide [**Standard**][**Special Purpose**] type.
2. Colors and Patterns: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**] .

2.9 TILE BACKING PANELS

A. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**American Gypsum**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Georgia-Pacific Gypsum LLC**]
    d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    e. [**PABCO Gypsum**]
    f. [**Panel Rey**]
    g. [**USG Corporation**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Gypsum**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Georgia-Pacific Gypsum LLC**]
    d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    e. [**PABCO Gypsum**]
    f. [**Panel Rey**]
    g. [**USG Corporation**]
    h. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type**

X][**Type C as required by fire-resistance-rated assembly indicated on Drawings**] .

B. Glass-Mat, Water-Resistant Gypsum Panel: ASTM C1658/C1658M, with fiberglass mat partially or completely embedded into the core.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   d. [**PABCO Gypsum**]
   e. [**Panel Rey**]
   f. [**USG Corporation**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   d. [**PABCO Gypsum**]
   e. [**Panel Rey**]
   f. [**USG Corporation**]
   g. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), abuse resistant**] .
4. Long Edges: Tapered.
5. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

C. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: ASTM C1178/C1178M, with a water-resistant coating on one surface, and manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**USG Corporation**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CertainTeed; SAINT-GOBAIN**]
   b. [**Georgia-Pacific Gypsum LLC**]
   c. [**USG Corporation**]

d. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**] .
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

D. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges in maximum lengths available to minimize end-to-end butt joints.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**C-Cure**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Custom Building Products**]
d. [**FinPan, Inc.**]
e. [**James Hardie Building Products, Inc.**]
f. [**PermaBASE Building Products, LLC provided by National Gypsum Company**]
g. [**USG Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**C-Cure**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Custom Building Products**]
d. [**FinPan, Inc.**]
e. [**James Hardie Building Products, Inc.**]
f. [**PermaBASE Building Products, LLC provided by National Gypsum Company**]
g. [**USG Corporation**]
h. <**Insert manufacturer's name**>

3. Thickness: [**1/4 inch (6.4 mm)**][**1/2 inch (12.7 mm)**][**5/8 inch (15.9 mm)**][**As indicated on Drawings**] .
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

E. Joint Treatment Materials for Tile Backing Panels: Comply with ASTM C475/C475M requirements.

1. Mold-Resistant Joint Compound: Use mold-resistant formulations with mold-resistant panel products.
2. Joint Tape: As recommended in writing by panel manufacturer.
3. Joint Compound for Tile Backing Panels: [**Use setting-type taping compound and setting-type, sandable topping compound**][**As recommended in writing by tile backing panel manufacturer**] .

2.10 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product [**, selected from the following,**] that complies with ANSI A118.10 [**and ANSI A118.12**] and is recommended in writing by manufacturer for application indicated. Include reinforcement and accessories recommended in writing by manufacturer.

B. Waterproof Membrane, Sheet: Polyethylene sheet faced on one or both sides with polyester fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ARDEX Americas**]
   b. [**Blanke Corporation**]
   c. [**Laticrete International, Inc.**]
   d. [**MAPEI Corporation**]
   e. [**Noble Company (The)**]
   f. [**Schluter Systems L.P.**]
   g. [**Schonox HPS North America, Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARDEX Americas**]
   b. [**Blanke Corporation**]
   c. [**Laticrete International, Inc.**]
   d. [**MAPEI Corporation**]
   e. [**Noble Company (The)**]
   f. [**Schluter Systems L.P.**]
   g. [**Schonox HPS North America, Inc.**]
   h. <**Insert manufacturer's name**>

3. Nominal Thickness: [**0.02 inch (0.5 mm)**][**0.03 inch (0.8 mm)**][**0.008 inch (0.2 mm)**]<**Insert thickness**> .

C. Waterproof Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Laticrete International, Inc.**]
   h. [**MAPEI Corporation**]
   i. [**National Applied Construction Products, Inc.**]
   j. [**Noble Company (The)**]
   k. [**Parex, a Sika brand**]
   l. [**Proflex USA**]
   m. [**Schonox HPS North America, Inc.**]
   n. [**Sika Corporation**]
   o. [**Southern Grouts & Mortars, Inc**]
   p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ARDEX Americas**]
    b. [**Boiardi Products Corporation; a QEP company**]
    c. [**Bostik; Arkema**]
    d. [**C-Cure**]
    e. [**Custom Building Products**]
    f. [**H.B. Fuller Construction Products Inc. / TEC**]
    g. [**Laticrete International, Inc.**]
    h. [**MAPEI Corporation**]
    i. [**National Applied Construction Products, Inc.**]
    j. [**Noble Company (The)**]
    k. [**Parex, a Sika brand**]
    l. [**Proflex USA**]
    m. [**Schonox HPS North America, Inc.**]
    n. [**Sika Corporation**]
    o. [**Southern Grouts & Mortars, Inc**]
    p. <**Insert manufacturer's name**>

3. Reinforcement: [**Continuous fabric reinforcement**][**None**] .

2.11 CRACK ISOLATION MEMBRANES

A. General: Manufacturer's standard product [**, selected from the following,**] that complies with ANSI A118.12 for [**standard performance**][**high performance**] and is recommended in writing by manufacturer for application indicated. Include reinforcement and accessories recommended in writing by manufacturer.

B. Crack Isolation Membrane, Polyethylene Sheet: Polyethylene faced on both sides with polyester fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Custom Building Products**]
    b. [**Laticrete International, Inc.**]
    c. [**MAPEI Corporation**]
    d. [**Noble Company (The)**]
    e. [**Proflex USA**]
    f. [**Schluter Systems L.P.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Custom Building Products**]
    b. [**Laticrete International, Inc.**]
    c. [**MAPEI Corporation**]
    d. [**Noble Company (The)**]
    e. [**Proflex USA**]
    f. [**Schluter Systems L.P.**]

g. **<Insert manufacturer's name>**

C. Crack Isolation Membrane, Asphaltic Sheet: Self-adhering, modified-asphalt sheet.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Boiardi Products Corporation; a QEP company**]
   b. [**Custom Building Products**]
   c. [**Laticrete International, Inc.**]
   d. [**MAPEI Corporation**]
   e. [**National Applied Construction Products, Inc.**]
   f. [**Sika Corporation**]
   g. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**Boiardi Products Corporation; a QEP company**]
   b. [**Custom Building Products**]
   c. [**Laticrete International, Inc.**]
   d. [**MAPEI Corporation**]
   e. [**National Applied Construction Products, Inc.**]
   f. [**Sika Corporation**]
   g. **<Insert manufacturer's name>**

3. Facing: [**Fabric reinforcement**][**None**] .

D. Crack Isolation Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Bostik; Arkema**]
   b. [**C-Cure**]
   c. [**Custom Building Products**]
   d. [**H.B. Fuller Construction Products Inc. / TEC**]
   e. [**Jamo Inc**]
   f. [**Laticrete International, Inc.**]
   g. [**MAPEI Corporation**]
   h. [**Parex, a Sika brand**]
   i. [**Siena Tile & Stone Installation Products; Omega Products International**]
   j. [**Sika Corporation**]
   k. [**Southern Grouts & Mortars, Inc**]
   l. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Bostik; Arkema**]
b. [**C-Cure**]
c. [**Custom Building Products**]
d. [**H.B. Fuller Construction Products Inc. / TEC**]
e. [**Jamo Inc**]
f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]
i. [**Siena Tile & Stone Installation Products; Omega Products International**]
j. [**Sika Corporation**]
k. [**Southern Grouts & Mortars, Inc**]
l. <**Insert manufacturer's name**>

3. Reinforcement: [**Continuous fabric reinforcement**][**None**] .

2.12 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.

1. Cleavage Membrane: Installer's option of material that complies with ANSI A108.02, paragraph 3.8.
2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, **2 by 2 inches (50.8 by 50.8 mm)** by **0.062-inch (1.57-mm)** diameter; comply with ASTM A1064/A1064M except for minimum wire size.
3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C847.

a. Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
b. Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
c. Configuration over Studs and Furring: Flat.
d. Configuration over Solid Surfaces: Self-furring.
e. Weight: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**] .

4. Latex Additive: [**Manufacturer's standard**][**acrylic resin**][**or**][**styrene-butadiene-rubber**] water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended in writing by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.

B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Proflex USA**]

k. [**Siena Tile & Stone Installation Products; Omega Products International**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Proflex USA**]
k. [**Siena Tile & Stone Installation Products; Omega Products International**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]
n. <**Insert manufacturer's name**>

3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.1.

C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Proflex USA**]
k. [**Schluter Systems L.P.**]
l. [**Siena Tile & Stone Installation Products; Omega Products International**]
m. [**Southern Grouts & Mortars, Inc**]
n. [**Summitville Tiles, Inc.**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]

b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Proflex USA**]
k. [**Schluter Systems L.P.**]
l. [**Siena Tile & Stone Installation Products; Omega Products International**]
m. [**Southern Grouts & Mortars, Inc**]
n. [**Summitville Tiles, Inc.**]
o. <**Insert manufacturer's name**>

3. Dry-Mortar Mix with Additive: Provide prepackaged, dry-mortar mix containing dry, redispersible, [**vinyl acetate**][**or**][**acrylic**] additive to which only water must be added at Project site.
4. Dry-Mortar Mix with Liquid-Latex Additive: Provide prepackaged, dry-mortar mix combined with [**acrylic resin**][**or**][**styrene-butadiene-rubber**] liquid-latex additive at Project site.
5. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.4.

D. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Custom Building Products**]
c. [**H.B. Fuller Construction Products Inc. / TEC**]
d. [**Laticrete International, Inc.**]
e. [**MAPEI Corporation**]
f. [**Parex, a Sika brand**]
g. [**Proflex USA**]
h. [**Siena Tile & Stone Installation Products; Omega Products International**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Custom Building Products**]
c. [**H.B. Fuller Construction Products Inc. / TEC**]
d. [**Laticrete International, Inc.**]
e. [**MAPEI Corporation**]
f. [**Parex, a Sika brand**]
g. [**Proflex USA**]
h. [**Siena Tile & Stone Installation Products; Omega Products International**]
i. <**Insert manufacturer's name**>

3. Dry-Mortar Mix with Additive: Provide prepackaged, dry-mortar mix containing dry, redispersible, [**vinyl acetate**][**or**][**acrylic**] additive to which only water must be added at Project site.
4. Dry-Mortar Mix with Liquid-Latex Additive: Provide prepackaged, dry-mortar mix combined with

[**acrylic resin**][**or**][**styrene-butadiene-rubber**] liquid-latex additive at Project site.

5. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.15.

E. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thinset): ANSI A118.11.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ARDEX Americas**]
   b. [**C-Cure**]
   c. [**Custom Building Products**]
   d. [**H.B. Fuller Construction Products Inc. / TEC**]
   e. [**Laticrete International, Inc.**]
   f. [**MAPEI Corporation**]
   g. [**Parex, a Sika brand**]
   h. [**Proflex USA**]
   i. [**Southern Grouts & Mortars, Inc**]
   j. [**Summitville Tiles, Inc.**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARDEX Americas**]
   b. [**C-Cure**]
   c. [**Custom Building Products**]
   d. [**H.B. Fuller Construction Products Inc. / TEC**]
   e. [**Laticrete International, Inc.**]
   f. [**MAPEI Corporation**]
   g. [**Parex, a Sika brand**]
   h. [**Proflex USA**]
   i. [**Southern Grouts & Mortars, Inc**]
   j. [**Summitville Tiles, Inc.**]
   k. <**Insert manufacturer's name**>

3. Dry-Mortar Mix with Additive: Provide prepackaged, dry-mortar mix containing dry, redispersible, [**vinyl acetate**][**or**][**acrylic additive**] to which only water must be added at Project site.
4. Dry-Mortar Mix with Liquid-Latex Additive: Provide prepackaged, dry-mortar mix combined with [**acrylic resin**][**or**][**styrene-butadiene-rubber**] liquid-latex additive at Project site.

F. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ARDEX Americas**]
   b. [**Atlas Minerals & Chemicals, Inc**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]

e. [**Custom Building Products**]
f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]
i. [**Southern Grouts & Mortars, Inc**]
j. [**Summitville Tiles, Inc.**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Atlas Minerals & Chemicals, Inc**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]
i. [**Southern Grouts & Mortars, Inc**]
j. [**Summitville Tiles, Inc.**]
k. <**Insert manufacturer's name**>

3. Verify adhesives have a VOC content of [**65**]<**Insert number**> g/L or less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.
7. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to **140 and 212 deg F (60 and 100 deg C)**, respectively, and certified by manufacturer for intended use.

G. Organic Adhesive: ANSI A136.1, Type [**I**][**II**] .

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]

i. [**Siena Tile & Stone Installation Products; Omega Products International**]
j. [**Southern Grouts & Mortars, Inc**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Laticrete International, Inc.**]
g. [**MAPEI Corporation**]
h. [**Parex, a Sika brand**]
i. [**Siena Tile & Stone Installation Products; Omega Products International**]
j. [**Southern Grouts & Mortars, Inc**]
k. <**Insert manufacturer's name**>

3. Verify adhesives have a VOC content of [**65**]<**Insert number**> g/L or less.
4. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

H. Chemical-Resistant Furan Mortar: ANSI A118.5.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Atlas Minerals & Chemicals, Inc**]
b. [**Sauereisen**]
c. [**Summitville Tiles, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atlas Minerals & Chemicals, Inc**]
b. [**Sauereisen**]
c. [**Summitville Tiles, Inc.**]
d. <**Insert manufacturer's name**>

3. Filler Material: [**Carbon**][**Silica**]<**Insert material**> .

2.13 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. Standard Cement Grout: ANSI A118.6.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Siena Tile & Stone Installation Products; Omega Products International**]
l. [**Sika Corporation**]
m. [**Southern Grouts & Mortars, Inc**]
n. [**Summitville Tiles, Inc.**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Siena Tile & Stone Installation Products; Omega Products International**]
l. [**Sika Corporation**]
m. [**Southern Grouts & Mortars, Inc**]
n. [**Summitville Tiles, Inc.**]
o. <**Insert manufacturer's name**>

C. High-Performance Tile Grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**ARDEX Americas**]
b. [**Bostik; Arkema**]
c. [**Custom Building Products**]
d. [**H.B. Fuller Construction Products Inc. / TEC**]
e. [**Laticrete International, Inc.**]
f. [**MAPEI Corporation**]
g. [**Parex, a Sika brand**]
h. [**Proflex USA**]
i. [**Southern Grouts & Mortars, Inc**]
j. [**Summitville Tiles, Inc.**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Bostik; Arkema**]
c. [**Custom Building Products**]
d. [**H.B. Fuller Construction Products Inc. / TEC**]
e. [**Laticrete International, Inc.**]
f. [**MAPEI Corporation**]
g. [**Parex, a Sika brand**]
h. [**Proflex USA**]
i. [**Southern Grouts & Mortars, Inc**]
j. [**Summitville Tiles, Inc.**]
k. <**Insert manufacturer's name**>

3. Polymer Type: [**Dry, redispersible form, prepackaged with other dry ingredients**][**Liquid-latex form for addition to prepackaged dry-grout mix**] .

D. Water-Cleanable Epoxy Grout: ANSI A118.3.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Sika Corporation**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]
m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**Sika Corporation**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]
m. <**Insert manufacturer's name**>

3. Maximum VOC Content: 65 g/L or less.
4. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to **140 and 212 deg F (60 and 100 deg C)**, respectively, and certified by manufacturer for intended use.

E. Chemical-Resistant Furan Grout: ANSI A118.5, with carbon filler.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Atlas Minerals & Chemicals, Inc**]
b. [**Sauereisen**]
c. [**Summitville Tiles, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atlas Minerals & Chemicals, Inc**]
b. [**Sauereisen**]
c. [**Summitville Tiles, Inc.**]
d. <**Insert manufacturer's name**>

F. Grout for Pregrouted Tile Sheets: Same product used in factory to pregrout tile sheets.

2.14 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting and adhesive materials for installations indicated.

B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D4397, **4.0 mils (0.1 mm)** thick.

C. Metal Flooring Transitions: Profile designed specifically for flooring applications; height to match tile and setting-bed thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Blanke Corporation**]
    b. [**Dural USA, Inc.**]
    c. [**Profilitec Corp.**]
    d. [**Progress Profiles America Inc.**]
    e. [**Schluter Systems L.P.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Blanke Corporation**]
    b. [**Dural USA, Inc.**]
    c. [**Profilitec Corp.**]
    d. [**Progress Profiles America Inc.**]
    e. [**Schluter Systems L.P.**]
    f. <**Insert manufacturer's name**>

3. Profile: [**L-shaped**][**Square**]<**Insert profile**> .
4. Material and Finish: Metallic or combination of metal and PVC or neoprene base; [**chrome-plated brass**][**polished chrome anodized aluminum**][**polished nickel anodized aluminum**][**color-coated aluminum**][**half-hard brass**][**white zinc alloy**]<**Insert finish**> exposed-edge material.

    a. Color: [**Brown**][**White**][**Gray**]<**Insert color**> .

D. Metal Edge Trim: Profile designed for wall terminations and edge protection.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Blanke Corporation**]
    b. [**Dural USA, Inc.**]
    c. [**Profilitec Corp.**]
    d. [**Progress Profiles America Inc.**]
    e. [**Schluter Systems L.P.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Blanke Corporation**]
    b. [**Dural USA, Inc.**]
    c. [**Profilitec Corp.**]
    d. [**Progress Profiles America Inc.**]
    e. [**Schluter Systems L.P.**]
    f. <**Insert manufacturer's name**>

3. Profile: [**L-shaped**][**Square**][**Beveled**]<**Insert profile**> .
4. Terminations: [**End caps**][**Inside corners**][**Outside corners**] matching edge-protection profile.
5. Material and Finish: [**Chrome-plated brass**][**Polished chrome anodized aluminum**][**Polished nickel anodized aluminum**][**Color-coated aluminum**]<**Insert finish**> exposed-edge material.

    a. Color: [**Brown**][**White**][**Gray**]<**Insert color**> .

E. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.

F. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

G. Grout Sealer: Grout manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with [**adhesives**][**bonded mortar bed**][**or**][**thinset mortar**] comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.

B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with [**adhesives**][**or**][**thinset mortar**] with trowelable leveling and patching compound specifically recommended in writing by tile-setting material manufacturer.

C. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1 and is sloped **1/4 inch per foot (1:50)** toward drains.

D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

E. Substrate Flatness:

1. For tile shorter than **15 inches (381 mm)**, confirm that structure or substrate is limited to variation of **1/4 inch in 10 ft. (6.4 mm in 3 m)** from the required plane, and no more than **1/16 inch in 12 inches (1.5 mm in 300 mm)** when measured from tile surface high points.
2. For large format tile, tile with at least one edge **15 inches (381 mm)** or longer, confirm that structure or substrate is limited to **1/8 inch in 10 ft. (3 mm in 3 m)** from the required plane, and no more than **1/16 inch in 24 inches (1.5 mm in 609 mm)** when measured from tile surface high points.

F. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 INSTALLATION OF CERAMIC TILE SYSTEM, GENERAL

A. Tile Backing Panels: Install backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

B. Waterproof Membranes: Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

C. Crack Isolation Membranes: Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

1. Allow crack isolation membrane to cure before installing tile or setting materials over it.

D. Setting and Grout Materials: Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

1. Add materials, water, and additives in accurate proportions.
2. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

E. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in ANSI A108 series of tile installation standards

for providing 95 percent mortar coverage:

a. Exterior tile floors and walls.
b. Tile floors in wet areas.
c. Tile swimming pool decks.
d. Tile floors in laundries.
e. Tile floors consisting of tiles **8 by 8 inches (200 by 200 mm)** or larger.
f. Tile floors consisting of rib-backed tiles.

2. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
3. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
4. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
5. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
6. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

   a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets, so joints between sheets are not apparent in finished Work.
   b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

7. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

F. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

G. Thresholds: Install stone and solid surface thresholds in same type of setting bed as adjacent floor unless otherwise indicated.

1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in [**modified dry-set mortar (thinset)**][**improved modified dry-set mortar (thinset)**] .
2. Do not extend [**cleavage membrane**][**waterproof membrane**][**or**][**crack isolation membrane**] under thresholds set in [**standard dry-set mortar (thinset)**][**modified dry-set mortar (thinset)**][**or**][**improved modified dry-set mortar (thinset)**] . Fill joints between such thresholds and adjoining tile set on [**cleavage membrane**][**waterproof membrane**][**or**][**crack isolation membrane**] with elastomeric sealant.

H. Metal Flooring Transitions: Install [**at locations indicated**][**where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile**][**where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated**] .

I. Metal Wall Trim: Install at locations indicated on Drawings.

J. Grout Sealer: Apply grout sealer to [**cementitious**] grout joints [**in tile floors**] in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 FIELD QUALITY CONTROL

A. Water Test:

1. Test of waterproofing membrane in showers and similar areas to be performed by Installation Contractor before setting tile.

    a. Perform test after 24 hours of waterproof membrane installation.
    b. Insert test plug in drain or waste line.
    c. Fill shower base with water, high enough that the membrane-to-drain connection and floor-to-wall transition can be evaluated, and mark wall.
    d. Check for leaks after 24 hours.

2. Test to be witnessed by [**Architect**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**> .

B. Nonconforming Work:

1. Waterproof membrane will be considered defective if water level has dropped.
2. Remove and replace defective components and retest.

3.5 ADJUSTING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

3.6 CLEANING

A. On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile in accordance with tile and grout manufacturer's written instructions. Use only cleaners recommended in writing by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.7 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended in writing by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.8 EXTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Exterior Floor Installations:

1. TCNA F101: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) [**bonded to concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated**] .

    a. Location: .
    b. Ceramic Tile Type: <**Insert tile-type designation**> .
    c. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
    d. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**] .

        1) Type: [**Sanded**][**Unsanded**] .

    e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid applied**][**Fabric reinforced, fluid applied**] .
    f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
    g. Movement Joints: Types located on Drawings.

2. TCNA F102: Thinset mortar [**on concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**][**over crack isolation membrane on concrete**][**over crack isolation membrane on concrete where indicated and on concrete where membrane is not indicated**] .

    a. Location: .
    b. Ceramic Tile Type: <**Insert tile-type designation**> .
    c. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
    d. Grout: [**Standard cement grout**][**High-performance tile grout**] .

        1) Type: [**Sanded**][**Unsanded**] .

    e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
    f. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
    g. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
    h. Movement Joints: Types located on Drawings.

B. Exterior Roof/Deck Floor Installations:

1. TCNA F103: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed

(thickset) [**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**] over drainage material on roof membrane.

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Bond Coat for Cured-Bed Method: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
g. Movement Joints: Types located on Drawings.

2. TCNA F104: Thinset mortar [**on concrete**][**over waterproof membrane on concrete**][**over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated**][**over crack isolation membrane on concrete**][**over crack isolation membrane on concrete where indicated and on concrete where membrane is not indicated**] .

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Thinset Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Standard cement grout**][**High-performance tile grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
g. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
h. Movement Joints: Types located on Drawings.

C. Exterior Wall Installations, Masonry or Concrete:

1. TCNA W201: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) installed on metal lath [**over waterproof membrane**][**over water-resistant barrier**][**over vapor-retarder membrane**] .

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Bond Coat for Cured-Bed Method: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset**] .
d. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Weather Barrier: Compliant with local code requirements [**and**][**specified in Division 07**] .
g. Vapor-Retarder Membrane: Compliant with local code requirements [**and**][**specified in Division 07**] .
h. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
i. Movement Joints: Types located on Drawings.

2. TCNA W202E: Thinset mortar [**over waterproof membrane**][**over water-resistive barrier**][**over vapor retarder membrane**] .

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset**] .
d. Grout: [**Standard cement grout**][**High-performance tile grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Weather Barrier: Compliant with local code requirements [**and**][**specified in Division 07**] .
g. Vapor-Retarder Membrane: Compliant with local code requirements [**and**][**specified in Division 07**] .
h. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
i. Movement Joints: Types located on Drawings.

D. Exterior Wall Installations, Wood or Metal Studs:

1. TCNA W244E: Thinset mortar [**over waterproof membrane on cementitious backer units**][**on cementitious backer units over vapor-retarder membrane**][**on cementitious backer units over water-resistive barrier**] .

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Standard cement grout**][**High-performance tile grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Weather Barrier: Compliant with local code requirements [**and**][**specified in Division 07**] .
g. Vapor-Retarder Membrane: Compliant with local code requirements [**and**][**specified in Division 07**] .
h. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
i. Movement Joints: Types located on Drawings.

3.9 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

1. TCNA F111: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) installed over cleavage membrane.

   a. Location: .
   b. Ceramic Tile Type: <**Insert tile-type designation**> .
   c. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   d. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

   e. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
   f. Movement Joints: Types located on Drawings.

2. TCNA F125-Full: Thinset mortar on crack isolation membrane.

   a. Location: .
   b. Ceramic Tile Type: <**Insert tile-type designation**> .
   c. Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   d. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

   e. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
   f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
   g. Movement Joints: Types located on Drawings.

B. Interior Floor Installations, Wood Subfloor:

1. TCNA F141: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) installed over cleavage membrane [**over waterproof membrane**] .

   a. Location: .
   b. Ceramic Tile Type: <**Insert tile-type designation**> .
   c. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
   d. Grout: [**Sand-portland cement**][**Standard cement grout**][**High-performance sanded cement**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

      1) Type: [**Sanded**][**Unsanded**] .

   e. Waterproof Membrane: [**As recommended in writing by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .

f. Joint Width: [1/8 inch (3.2 mm)][3/16 inch (4.76 mm)][1/4 inch (6.4 mm)][3/8 inch (9.5 mm)]<**Insert width**> .
g. Movement Joints: Types located on Drawings.

2. TCNA F142: Organic adhesive on plywood underlayment.

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

d. Joint Width: [1/8 inch (3.2 mm)][3/16 inch (4.76 mm)][1/4 inch (6.4 mm)][3/8 inch (9.5 mm)]<**Insert width**> .
e. Movement Joints: Types located on Drawings.

C. Interior Radiant Heat Floor Installations, Concrete Subfloor:

1. TCNA RH110: Thinset mortar [**on crack isolation membrane**] ; hydronic piping installed in concrete.

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Joint Width: [1/8 inch (3.2 mm)][3/16 inch (4.76 mm)][1/4 inch (6.4 mm)][3/8 inch (9.5 mm)]<**Insert width**> .
g. Movement Joints: Types located on Drawings.

2. TCNA RH115: Thinset mortar; electric radiant system encapsulated in thinset mortar.

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Joint Width: [1/8 inch (3.2 mm)][3/16 inch (4.76 mm)][1/4 inch (6.4 mm)][3/8 inch (9.5 mm)]<**Insert width**> .
f. Movement Joints: Types located on Drawings.

D. Interior Radiant Heat Floor Installations, Wood Subfloor:

1. TCNA RH130: Thinset mortar on exterior-glue plywood; electric radiant system encapsulated in

thinset mortar.

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Mortar: [**EGP (exterior glue plywood) latex-portland cement mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
f. Movement Joints: Types located on Drawings.

2. TCNA RH141: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) installed over cleavage membrane [**and waterproof membrane**] with hydronic piping installed in mortar bed.

a. Location: .
b. Ceramic Tile Type: <**Insert stone tile-type designation**> .
c. Bond Coat for Cured-Bed Method: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
g. Movement Joints: Types located on Drawings.

E. Interior Wall Installations, Masonry or Concrete:

1. TCNA W202I: Thinset mortar [**over waterproof membrane**] .

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**][**Water-cleanable, tile-setting epoxy**] .
d. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
g. Movement Joints: Types located on Drawings.

2. TCNA W211: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) bonded to substrate [**over waterproof membrane**] .

    a. Location: .
    b. Ceramic Tile Type: <**Insert tile-type designation**> .
    c. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
    d. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

        1) Type: [**Sanded**][**Unsanded**] .

    e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
    f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
    g. Movement Joints: Types located on Drawings.

F. Interior Wall Installations, Wood or Metal Studs or Furring:

1. TCNA W242: Organic adhesive on gypsum board.

    a. Location: .
    b. Ceramic Tile Type: <**Insert tile-type designation**> .
    c. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

        1) Type: [**Sanded**][**Unsanded**] .

    d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
    e. Movement Joints: Types located on Drawings.

2. TCNA W245: Thinset mortar on glass-mat, water-resistant gypsum backer board [**over waterproof membrane**] .

    a. Location: .
    b. Ceramic Tile Type: <**Insert tile-type designation**> .
    c. Mortar: [**Standard dry-set mortar**][**Modified dry-set mortar**][**Improved modified dry-set mortar**] .
    d. Grout: [**Sand-portland cement grout**][**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

        1) Type: [**Sanded**][**Unsanded**] .

    e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
    f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
    g. Movement Joints: Types located on Drawings.

G. Bathtub Wall Installations with No Shower Head, Wood or Metal Studs or Furring:

1. TCNA B413: [**Thinset mortar**][**Organic adhesive**] on [**water-resistant gypsum**][**coated glass-**

mat, water-resistant gypsum] backer board.

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Thinset Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Sand-portland cement grout**][**Standard sanded cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
f. Movement Joints: Types located on Drawings.

H. Bathtub/Shower Wall Installations:

1. TCNA B419: Thinset mortar [**over waterproof membrane**] on coated glass-mat, water-resistant gypsum backer board.

a. Location: .
b. Ceramic Tile Type: <**Insert tile-type designation**> .
c. Mortar: [**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Standard cement grout**][**High-performance tile grout**][**Water-cleanable epoxy grout**] .

1) Type: [**Sanded**][**Unsanded**] .

e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
g. Movement Joints: Types located on Drawings.

3.10 CHEMICAL-RESISTANT TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete:

1. TCNA F115: Thinset mortar [**over crack isolation membrane**] .

a. Location: .
b. Chemical-Resistant Tile Type: <**Insert tile-type designation**> .
c. Mortar: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset)**] .
d. Grout: [**Water-cleanable epoxy grout**][**Chemical-resistant furan grout**] .
e. Crack Isolation Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Asphaltic sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
g. Movement Joints: Types located on Drawings.

2. TCNA F131: Water-cleanable, tile-setting epoxy.

    a. Location: .
    b. Chemical-Resistant Tile Type: <**Insert tile-type designation**> .
    c. Grout: Water-cleanable epoxy grout.
    d. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
    e. Movement Joints: Types located on Drawings.

B. Interior Wall Installations, Masonry or Concrete:

1. TCNA W211: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . Cement mortar bed (thickset) bonded to substrate [**over waterproof membrane**] .

    a. Location: .
    b. Chemical-Resistant Tile Type: <**Insert tile-type designation**> .
    c. Bond Coat for Cured-Bed Method: [**Dry-set**][**Latex-**] portland cement mortar.
    d. Grout: Water-cleanable epoxy.
    e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
    f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
    g. Movement Joints: Types located on Drawings.

C. Interior Wall Installations, Solid Backing:

1. TCNA W222: Method [**ANSI A108.1A**][**ANSI A108.1B**][**ANSI A108.1C**] . One-coat cement mortar bed (thickset) installed [**over cleavage membrane**][**over waterproof membrane**] on solid backing.

    a. Location: .
    b. Chemical-Resistant Tile Type: <**Insert tile-type designation**> .
    c. Bond Coat for Cured-Bed Method: [**Standard dry-set mortar (thinset)**][**Modified dry-set mortar (thinset)**][**Improved modified dry-set mortar (thinset**] .
    d. Grout: Water-cleanable epoxy grout.
    e. Waterproof Membrane: [**As recommended by setting material manufacturer**][**Polyethylene sheet**][**Fluid-applied membrane**][**Fabric-reinforced, fluid-applied membrane**] .
    f. Joint Width: [**1/8 inch (3.2 mm)**][**3/16 inch (4.76 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**]<**Insert width**> .
    g. Movement Joints: Types located on Drawings.

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SECTION 09 01 60 91 - POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stain materials.
2. Liquid floor treatments.
3. Polished concrete surface finish requirements.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for new concrete designed for polished concrete finishing, including concrete materials, mixture design, placement procedures, initial finishing, and curing.

1.2 DEFINITIONS

A. Aggregate Exposure Class: Visual observation of polished floor aggregate surface exposure area after grinding and polishing operations. Aggregate exposure class ranges are A, B, and C.

B. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.

C. Distinctness of Image (DOI): The distinctness (clarity) of images reflected by the glossy coating surface appearance of the polished concrete finish appearance levels. The transmission of this reflection is measured in accordance with ASTM D5767.

D. Haze: The cloudiness or milky appearance of images from objects produced by reflection in a polished concrete surface. The measurement of this appearance is defined in accordance with ASTM D4039. The test method reading is put into a calculation resulting in a Haze Index value.

E. Specular Gloss: A reflectance value determined by a single measurement of gloss from shining a known amount of light at a surface within a specific angle of illumination in accordance with ASTM D523.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with polished concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place concrete subcontractor.
e. Polished concrete finishing subcontractor.

f. Architect.
g. The Owner.

2. Review [**concrete slab design for compressive strength, flatness and levelness,**][**cold- and hot-weather concreting procedures,**][**curing procedures,**][**sequencing,**][**construction joints,**][**concrete repair procedures,**][**concrete finishing,**] polished concrete appearance and aggregate exposure requirements, polished concrete mockups, and protection of polished concrete.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Laboratory Test Reports: For [**stains**][**and**][**liquid floor treatments**], indicating compliance with requirements for low-emitting materials.

C. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of product requiring color selection.

E. Samples for Verification: Actual sample of finished products for each type of exposed color.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. An installer experienced in performing polished concrete finishing with a minimum of five previous projects similar in material, design, and extent to that indicated for this Project.
2. Trained and certified by manufacturer of polished concrete system materials.
3. Concrete Polishing Craftsman of the Concrete Polishing Council.

B. Polished Concrete Standards: Comply with ACI 310.1.

1.6 MOCKUPS

A. Build mockups [**10 by 10 ft (3.05 by 3.05 m)**]to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location of the Work and of the size indicated or, if not indicated, as directed by the Owner for [**newly placed**][**existing**] concrete.
2. Demonstrate surface preparation, [**coloring,**][**pattern,**][**curing,**] tested aggregate exposure, tested polish appearance, sealing and protecting of polished concrete.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
4. Remove rejected mockups.

1.7 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as needed for other construction activities.

B. Ambient Conditions: Ensure installation location and Project ambient conditions comply with manufacturers written instructions.

PART 2 - PRODUCTS

2.1 STAIN MATERIALS

A. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**Artcrete, Inc**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Decosup Inc.**]
h. [**EPMAR Corporation; a Quaker Houghton company**]
i. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
j. [**QC Construction Products**]
k. [**Scofield, a Business Unit of Sika Corporation**]
l. [**Specialty Concrete Products, Inc**]
m. [**Stampcrete International, Ltd**]
n. [**Super Stone, Inc.**]
o. [**SureCrete Design Products, a Fenix Group SPC Company**]

B. Penetrating Stain: Coloring agents used to add consistent color to polished concrete surfaces without coloring the aggregates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Americrete, Inc.**]
b. [**AmeriPolish**]
c. [**Bomanite Co**]
d. [**Bon Tool Co.**]
e. [**Brickform; a division of Solomon Colors**]
f. [**Butterfield Color, Inc.**]
g. [**Duckback Products**]

h. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
i. [**Scofield, a Business Unit of Sika Corporation**]
j. [**Super Stone, Inc.**]

C. VOC Content: For field applications[**that are inside the weatherproofing system**], verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Primers, Sealers, and Undercoaters: 100 g/L.
2. Clear Wood Finishes, Varnishes: 275 g/L.
3. Clear Wood Finishes, Lacquers: 275 g/L.
4. Shellacs, Clear: 730 g/L.
5. Stains: 100 g/L.

D. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Verify not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

F. VOC Emissions: For field applications inside the building, verify wall paints contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.2 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear liquid materials for the applications of cleaning solutions, densifiers, and sealers that strengthen or protect polished concrete surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Advanced Floor Products**]
b. [**AmeriPolish**]
c. [**ARDEX Americas**]
d. [**AWRC Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]

i. [**Moxie International**]
j. [**NewLook International, Inc.**]
k. [**Nox-Crete Products Group**]
l. [**PROSOCO, Inc**]
m. [**QuestMark**]
n. [**Vexcon Chemicals Inc.**]

2. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 POLISHED CONCRETE SURFACE FINISH REQUIREMENTS

A. Aggregate Exposure Class: [**Class A Cement Fines 85 to 95 percent fines; 5 to 15 percent fine aggregate**][**Class B Fine Aggregate 85 to 95 percent fine aggregate; 5 to 15 percent blend of fines and coarse aggregate**][**Class C Coarse Aggregate 10 to 20 percent cement fines and fine aggregates**].

B. Polish Concrete Appearance Levels: [**Level 1: Flat (Ground) up to 100-grit polish; DOI 0 to 9; Haze Reading less than 10**][**Level 2: Satin (Honed) up to 200- to 400-grit polish; DOI 10 to 39; Haze Reading less than 10; Reflective Sheen: Low to medium**][**Level 3: Polished (Polished Gloss up to 400- to 800-grit polish; DOI 40 to 69; Haze Reading less than 10; Reflective Sheen: Medium to high**][**Level 4: Highly Polished (Very High Gloss) 800-grit and higher polish; DOI 70 to 100; Haze Reading less than 10; Reflective Sheen: High to highest**][**Match design reference sample**].

C. Slip Resistance: Minimum Dynamic Coefficient of Friction (DCOF) of 0.42. Provide required slip resistance based on final gloss level and determined by the Concrete Polishing Council.

2.4 ACCESSORIES

A. Repair Materials: As recommended in writing by manufacturer to repair and fill cracks, and repair surfaces compatible with polishing materials.

B. Water: Potable.

C. Cleaning Agents: As recommended in writing by manufacturer.

2.5 POLISHING EQUIPMENT

A. Equipment and Supplies: Provide equipment and supplies, not limited to, the concrete grinding and concrete polisher equipment, tooling and polishing diamonds for the polished concrete finishing Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that concrete substrates are acceptable for grinding, polishing and product installation as recommended by manufacturer.

B. Do not begin Work until unsatisfactory conditions have been addressed and corrected.

3.2 PREPARATION

A. Verify that concrete substrate preparation is in accordance with manufacturer's written instructions.

B. Clean surfaces free of dust, dirt and other contaminates incompatible with liquids applied products and polishing.

C. Clean and seal cracks as recommended by manufacturer.

D. Prepare, clean and fill joints with joint filler as recommended in writing by manufacturer.

E. Clean surface completely of any dust with cleaning solution as recommended in writing by manufacturer.

3.3 APPLICATION

A. Machine grind floor surfaces progressively to receive aggregate and polish appearance levels indicated to match approved mockup.

B. Scoring: Score decorative jointing in concrete surfaces **1/16 inch (1.6 mm)** deep with diamond blades to match pattern indicated. Rinse until water is clear. Score [**after**][**before**] staining.

1. Joint Width: [**3/8 inch (10 mm)**].

C. Apply penetrating stain densifier treatment for polished concrete in polishing sequence and in accordance with manufacturer's written instructions, allowing recommended drying time between successive coats.

D. Apply reactive color stain for polished concrete in polishing sequence and in accordance with manufacturer's written instructions.

E. Apply color dyes for polished concrete in polishing sequence and in accordance with manufacturer's written instructions.

F. Apply sealers to polished concrete in polishing sequence and in accordance with manufacturers' written instructions.

G. Continue progressively polishing to aggregate and polish appearance levels to match approved mockup for final finish appearance.

H. Visually inspect to remove defects and repolish areas that are defective. Repolish those areas that do not meet specified aggregate and polish levels per approved mockup.

I. Complete edges of floor finish that adjoins surrounding floor areas in a sharp and clean manner.

J. Neutralize and clean polished floor surfaces.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**the Owner**][**Engage**] a qualified testing and inspecting agency to perform tests at three random locations for areas up to **100 sq. ft. (465 sq. m)** and inspections and to submit reports.

B. Measure polish specular gloss level, DOI, and haze as specified; repolish if required to achieve Project requirements.

C. Verify aggregate exposure as specified. Machine surfaces if required to achieve Project requirements.

D. Verify compliance of slip resistance to comply with specified slip-resistance rating.

E. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Control and dispose of waste products produced by grinding and polishing operations.

B. Protect installed polished concrete surfaces from damage during construction in accordance with manufacturer's written instructions.

END OF SECTION 09 01 60 91

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SECTION 09 01 60 91A - PORTLAND CEMENT TERRAZZO FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Poured-in-place portland cement terrazzo flooring.
2. Poured-in-place rustic terrazzo flooring.
3. Precast terrazzo units.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealants installed with terrazzo.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to terrazzo including, but not limited to, the following:

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Review special terrazzo designs and patterns.
d. Review procedures for coping with unfavorable forecasted weather conditions.
e. <**Insert agenda items**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include terrazzo installation requirements. Include plans, sections, component details, and relationship to other work. Show layout of the following:

1. Divider strips.
2. Control-joint strips.
3. Expansion-joint strips.

4. Accessory strips.
5. Abrasive strips.
6. Stair treads, risers, and landings.
7. Precast terrazzo jointing and edge configurations.
8. Terrazzo patterns.
9. <**Insert requirements**>.

D. Samples: For each exposed product and for each color and texture specified, [**6 inches (150 mm)**]<**Insert dimension**> in size.

E. Samples for Initial Selection: NTMA's "Terrazzo Color Palette" showing the full range of colors and patterns available for each terrazzo type.

F. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo Sample to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in sizes indicated below:

1. Terrazzo: [**6-inch- (150-mm-)**]<**Insert dimension**> square Samples.
2. Precast Terrazzo: [**6-inch- (150-mm-)**]<**Insert dimension**> square Samples.
3. Accessories: [**6-inch- (150-mm-)**]<**Insert dimension**> long Samples of each exposed strip item required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each type of terrazzo material or product.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For terrazzo to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer who is a contractor member of NTMA.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for each type of terrazzo including accessories.

   a. Size: Minimum **100 sq. ft. (9 sq. m)** of typical poured-in-place flooring condition for each color and pattern [**in locations indicated**][**in locations directed by Architect**]<**Insert location requirements**>.
   b. Include [**base**][**first three stair treads**]<**Insert item**>.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Maintain interior ambient temperature above **50 deg F (10 deg C)** for 48 hours before and during terrazzo installation.

B. Weather Limitations: Proceed with rustic terrazzo installation only when forecasted weather conditions permit work to be performed according to NTMA's written recommendations and when temperatures remain above **45 deg F (7.2 deg C)**.

C. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

D. Provide permanent interior lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

E. Close spaces to traffic during terrazzo installation and for not less than 24 hours after installation unless manufacturer recommends a longer period.

F. Control and collect water and dust produced by portland cement terrazzo grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. NTMA Standards: Comply with NTMA's written recommendations for terrazzo type indicated unless more stringent requirements are specified.

2.3 PORTLAND CEMENT TERRAZZO

A. Portland Cement Terrazzo System <**Insert designation**>: [**Sand cushion**][**Bonded**][**Monolithic**].

1. Underbed Thickness: [**As indicated on Drawings**]<**Insert dimension**>.
2. Terrazzo Topping Thickness: [**As indicated on Drawings**]<**Insert dimension**>.

B. Materials:

1. Portland Cement: ASTM C150/C150M, Type 1.

    a. Color for Terrazzo Matrix: [**As required by mix indicated**]<**Insert requirements**>.

2. Water: Potable.
3. Sand: ASTM C33/C33M.
4. Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.

    a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M[**and ASTM C535 for large-size coarse aggregates**].
    b. 24-Hour Absorption Rate: Less than 0.75 percent.
    c. Dust Content: Less than 1.0 percent by weight.

5. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.
6. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight, and compatible with terrazzo matrix.
7. Underbed Bonding Agent: Neat portland cement paste.
8. Topping Bonding Agent: Neat portland cement paste, or epoxy or acrylic bonding agents formulated for use with monolithic terrazzo.
9. Underbed Reinforcement: Galvanized welded-wire reinforcement, wire **2 by 2 inches (51 by 51 mm)** by **0.062 inch (1.57 mm)** in diameter, complying with ASTM A1064/A1064M, except for minimum wire size.
10. Isolation Membrane: Polyethylene sheeting, ASTM D2103, Type 13300, **4 mils (0.1 mm)** thick; or unperforated asphalt felt, ASTM D226/D226M, Type I (No. 15).

C. Mixes:

1. Underbed Mix: One part portland cement to four parts sand and sufficient water to provide workability at as low a slump as possible.
2. Terrazzo Topping Mix: One **94-lb (42.6-kg)** bag of portland cement per [**200 lb (90.7 kg)**]<**Insert value**> of aggregate, matrix pigment if required by mix color, and sufficient water to produce a workable mix.

    a. Mix Color and Pattern: [**As selected by Architect from NTMA's "Terrazzo Color Palette" CI Series**][**As selected by Architect from NTMA's "Terrazzo Color Palette" CII Series**][**As selected by Architect from NTMA's "Terrazzo Color Palette" CIII Series**][**Match Architect's sample**][**Match existing**]<**Insert NTMA designation or custom mix**>.

2.4 RUSTIC TERRAZZO

A. Rustic Terrazzo System <**Insert designation**>: [**Bonded**][**Monolithic**].

1. Underbed Thickness: [**As indicated on Drawings**]<**Insert dimension**>.
2. Terrazzo Topping Thickness: [**As indicated on Drawings**]<**Insert dimension**>.

B. Materials:

1. Portland Cement: ASTM C150/C150M, Type 1.

    a. Color for Terrazzo Matrix: [**As required by mix indicated**]<**Insert requirements**>.

2. Water: Potable.
3. Sand: ASTM C33/C33M.
4. Aggregates: As required for mix indicated, in sizes comply with NTMA gradation standards, with maximum 24-hour absorption rate of 0.25 percent, and containing no deleterious or foreign matter.
5. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.
6. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight and weather, and compatible with matrix binder.
7. Air-Entraining Admixture: ASTM C260/C260M.
8. Underbed Bonding Agent: Neat portland cement paste.
9. Topping Bonding Agent: Neat portland cement paste, or epoxy or acrylic bonding agents formulated for use with topping indicated.

C. Mixes:

1. Underbed Mix: One part portland cement to four parts sand and sufficient water to provide workability at as low a slump as possible and air entrainment agent to produce 6 percent plus or minus 1 percent air content at point of delivery.
2. Terrazzo Topping Mix: One **94-lb (42.6-kg)** bag of portland cement per [**200 lb (90.7 kg)**]<**Insert value**> of aggregate, matrix pigment if required by mix color, and sufficient water to produce a workable mix.

    a. Mix Color and Pattern: [**As selected by Architect from NTMA's "Terrazzo Color Palette" CI Series**][**As selected by Architect from NTMA's "Terrazzo Color Palette" CII Series**][**As selected by Architect from NTMA's "Terrazzo Color Palette" CIII Series**][**Match Architect's sample**][**Match existing**]<**Insert NTMA designation or custom mix**>.

2.5 PRECAST TERRAZZO

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Precast Terrazzo Enterprises, Inc**]
2. [**Romoco Precast Terrazzo Products; a subsidiary of Roman Mosaic & Tile Company**]
3. [**Wausau Tile, Inc.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Precast Terrazzo Enterprises, Inc**]
2. [**Romoco Precast Terrazzo Products; a subsidiary of Roman Mosaic & Tile Company**]
3. [**Wausau Tile, Inc.**]
4. <**Insert manufacturer's name**>

C. Precast Terrazzo Base <**Insert designation**>: Minimum **3/4-inch- (19-mm-)** thick, reinforced, portland cement terrazzo units cast in maximum lengths possible, but not less than **36 inches (900 mm)**. Comply with NTMA's written recommendations for fabricating precast terrazzo base units in sizes and profiles indicated.

1. Type: [**As indicated**][**Coved with minimum 3/4-inch (19-mm) radius**][**Straight**][**Splayed**]<**Insert requirements**>.

2. Top Edge: [**Straight, unfinished**][**Beveled with polished top surface**][**Radius edge with polished top surface**]<**Insert requirements**>.
3. Metal Toe Strip: [**Zinc**][**Brass**].
4. Outside Corner Units: With finished returned edges at outside corner.
5. Color, Pattern, and Finish: [**As selected by Architect from full range of industry colors**][**Match Architect's sample**][**Match adjacent poured-in-place terrazzo flooring**]<**Insert requirements**>.

D. Precast Terrazzo Units <**Insert designation**>: Minimum [**2-inch- (51-mm-)**]<**Insert dimension**> thick, reinforced, portland cement terrazzo units. Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to **1/8-inch (3.2-mm)** radius.

1. Color, Pattern, and Finish: [**As selected by Architect from full range of industry colors**][**Match Architect's sample**][**Match adjacent poured-in-place terrazzo flooring**]<**Insert requirements**>.

2.6 STRIP MATERIALS

A. Standard Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in substrate.

1. Material: [**As indicated**][**White-zinc alloy**][**Brass**]<**Insert requirements**>.
2. Depth: [**As indicated**][**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**][**2 inches (51 mm)**]<**Insert dimension**>.
3. Width: [**As indicated**][**0.05 inch (1.27 mm)**][**1/8 inch (3.2 mm)**][**1/4 inch (6.4 mm)**]<**Insert dimension**>.

B. Heavy-Top Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in substrate.

1. Base-Section Material: [**As indicated**][**White-zinc alloy**][**Galvanized steel**]<**Insert requirements**>.
2. Top-Section Material: [**As indicated**][**White-zinc alloy**][**Brass**][**Plastic, in color selected from full range of industry colors**]<**Insert requirements**>.
3. Depth: [**As indicated**][**3/4 inch (19 mm)**][**1-1/4 inches (32 mm)**][**2 inches (51 mm)**]<**Insert dimension**>.
4. Top-Section Width: [**As indicated**][**1/8 inch (3.2 mm)**][**1/4 inch (6.4 mm)**][**1/2 inch (12.7 mm)**]<**Insert dimension**>.

C. Heavy-Top Angle Divider Strips: One-piece, L-type angle strips with anchoring device and in depth required for topping thickness indicated.

1. Material: [**As indicated**][**White-zinc alloy**][**Brass**][**Plastic, in color selected from full range of industry colors**]<**Insert requirements**>.
2. Top-Section Width: [**As indicated**][**1/8 inch (3.2 mm)**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**]<**Insert dimension**>.

D. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.

E. Expansion-Joint Strips: [**Brass**][**Plastic strips in color selected from full range of industry colors**], with removable zip-strip top for installing sealant.

1. Width: [**As indicated**][**Minimum 1/2 inch (12.7 mm)**]<**Insert dimension**>.

F. Accessory Strips: Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:

1. Base-bead strips for exposed top edge of terrazzo base.
2. Edge-bead strips for exposed edges of terrazzo.
3. Nosings for terrazzo stair treads and landings.
4. <**Insert requirements**>.

G. Abrasive Strips: [**Three-line**][**Two-line**][**One-line**][**Abrasive nosing strip and two-line**]<**Insert requirements**> abrasive inserts at nosings. Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.

1. Width: [**1/2 inch (12.7 mm)**]<**Insert dimension**>.
2. Depth: As required by terrazzo thickness.
3. Length: [**4 inches (100 mm) less than stair width**][**As indicated**]<**Insert dimension**>.
4. Color: [**As selected by Architect from full range of industry colors**]<**Insert requirements**>.

2.7 MISCELLANEOUS ACCESSORIES

A. Strip Adhesive: Recommended by manufacturer for this use.

1. Adhesives shall have a VOC content of [**70**]<**Insert value**> g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Anchoring Devices:

1. Strips: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and as required for secure attachment to substrate.
2. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

D. Isolation and Expansion-Joint Material: Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, and non-outgassing in unruptured state; butyl rubber; rubber; or cork; [**in width indicated**][**minimum 1/2 inch (12.7 mm) wide**]<**Insert dimension**>.

E. Portland Cement Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is

biodegradable, phosphate free, and recommended by cleaner manufacturer for use on terrazzo type indicated.

F. Rustic Terrazzo Cleaner: Solution of 1 part muriatic acid and 10 parts water.

G. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; is recommended by sealer manufacturer; and complies with NTMA's written recommendations for terrazzo type indicated.

1. Surface Friction: Not less than 0.6 according to ASTM D2047.
2. Acid-Base Properties: With pH factor between 7 and 10.
3. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
6. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Rustic Terrazzo: Use solvent acrylic-type sealer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.2 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.

1. Roughen concrete substrates before installing terrazzo system according to NTMA's written recommendations.

B. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.

1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during

installation.

3.3 INSTALLATION, GENERAL

A. Comply with NTMA's written recommendations for terrazzo and accessory installation.

B. Installation Tolerance: Limit variation in terrazzo surface from level to [**1/4 inch in 10 feet (6.4 mm in 3 m)**]<**Insert dimensions**>; noncumulative.

C. Rustic Terrazzo: Install isolation and expansion material where abutting adjacent construction and directly above substrate expansion joints.

D. Underbed:

1. Comply with NTMA's written recommendations for underbed installation.
2. Sand-Cushion Portland Cement Terrazzo:

a. Cover entire surface to receive terrazzo with dusting of sand.
b. Install isolation membrane over sand, overlapping ends and edges a minimum of **3 inches (75 mm)**.
c. Install welded-wire reinforcement, overlapping at edges and ends at least two squares.[**Stop mesh a minimum of 1 inch (25 mm) short of expansion joints.**]

3. Bonded [**Portland Cement**][**Rustic**] Terrazzo:

a. Saturate structural concrete substrate with water, and slush and broom with underbed bonding agent.

4. Place underbed and screed to elevation indicated below finished floor elevation.

E. Strip Materials:

1. Divider and Control-Joint Strips:

a. Locate divider strips [**directly over breaks and control joints in concrete slabs**][**in locations indicated**]<**Insert requirements**>.
b. Install control-joint strips [**back to back and directly above concrete-slab control joints**][**in locations indicated**]<**Insert requirements**>.

1) Install control-joint strips with [**1/4-inch (6.4-mm)**]<**Insert dimension**> gap between strips, and install sealant in gap.

c. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.

2. Expansion-Joint Strips: Form expansion joints using divider strips and install directly above concrete-slab expansion joints.
3. Accessory Strips: Install as required to provide a complete installation.
4. Abrasive Strips: Install with surface of abrasive strip positioned [**1/16 inch (1.6 mm)**]<**Insert dimension**> higher than terrazzo surface.

3.4 POURED-IN-PLACE TERRAZZO INSTALLATION

A. Underbed Preparation:

1. Sand-Cushion Portland Cement Terrazzo: Saturate underbed with water to produce a cement slurry.
2. Bonded [**Portland Cement**][**Rustic**] Terrazzo: Dampen underbed with water.

B. Monolithic [**Portland Cement**][**Rustic**] Terrazzo: Apply topping bonding agent on concrete substrate.

C. Place terrazzo mixture in panels formed by divider strips and trowel mixture to top of strips. Seed additional aggregates in matrix to uniformly distribute granular material and produce a surface with a minimum of 70 percent aggregate exposure. Roll and compact surface until excess cement and water have been extracted.

1. Portland Cement Terrazzo: Trowel to a dense, uniform, flat surface disclosing lines of divider strips.

D. Portland Cement Terrazzo Stairs: Install and finish stairs at the same time that adjacent flooring is installed.

E. Portland Cement Terrazzo Base: Install and finish base at the same time that adjacent flooring is installed.

F. Portland Cement Terrazzo Finishing: Cover terrazzo topping with moisture-retaining cover and cure until topping develops sufficient strength to prevent lifting or pulling of aggregate during grinding.

1. Rough Grinding: Grind with 24-grit or finer stones or with comparable diamond plates.
2. Grouting: After rough grinding, clean terrazzo topping with water and rinse away residue. Remove excess rinse water, apply matrix mix to grout surface, and fill voids. After grouting, cover surface with moisture-retaining cover to cure grout until ready for fine grinding.
3. Fine Grinding and Polishing: Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted. Grind with [**80**][**120**]-grit stones or with comparable diamond abrasives until grout is removed from surface.

G. Rustic Terrazzo Finishing: Expose aggregate by hosing or other means recommended in writing by NTMA. Cure the terrazzo topping by flooding with water or covering with moisture-retaining cover.

3.5 PRECAST TERRAZZO INSTALLATION

A. Install precast terrazzo units using method recommended in writing by NTMA and manufacturer unless otherwise indicated.

B. Do not install units that are chipped, cracked, discolored, or improperly finished.

C. Seal joints between units with [**cement grout matching precast terrazzo matrix**][**joint sealant**]<**Insert requirements**>.

3.6 REPAIR

A. Cut out and replace terrazzo areas that evidence lack of bond with substrate or underbed, including areas that emit a "hollow" sound if tapped. Cut out terrazzo areas in panels defined by strips and

replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect.

3.7 CLEANING AND PROTECTION

A. Terrazzo Cleaning:

1. Remove grinding dust from installation and adjacent areas.
2. Wash surfaces with cleaner immediately after final cleaning of terrazzo flooring according to both NTMA's and manufacturer's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.

B. Rustic Terrazzo Cleaning: Clean surfaces with rustic terrazzo cleaner. Legally contain and dispose of runoff from cleaning operations. Rinse surfaces with water and allow them to dry thoroughly.

C. Sealing:

1. Seal surfaces according to NTMA's written recommendations.
2. Apply sealer according to sealer manufacturer's written instructions.

D. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 01 60 91A

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SECTION 09 01 60 91B - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carpet tiles.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. [**Section 096513 "Resilient Base and Accessories"**][**Section 096519 "Resilient Tile Flooring"**] for resilient wall base and accessories installed with carpet tile.
3. Section 096816 "Sheet Carpeting" for carpet roll goods.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**]<**Insert location**> .

1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet tile installation, showing the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of carpet tile.

1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.

D. Samples for Verification: Actual Sample of finished products for each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: **12-inch- (300-mm-)** long Samples.

E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Health Product Declaration (HPD): Provide product's Material Health Certificate or Cradle to Cradle certification.
3. Declare, Action Submittals: Provide product's Declare product label, designated as "Red List Free," Declare, or Living Building Challenge (LBC) compliant to 0.1 percent.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.
13. Facts, Action Submittals: Provide product's Facts - NSF/ANSI 336, "Sustainability Assessment for Commercial Furnishings Fabric," certification.
14. Health Product Declaration (HPD): For each product.
15. Health Product Declaration (HPD): Provide HPD.
16. Life-Cycle Impact-Reduction Action Plan, Action Submittals: Provide product-specific, Life-Cycle Assessment (LCA) complying with EN 15804 or ISO 21930.
17. Supply Chain Optimization: For each product, provide documentation demonstrating that manufacturer practices comply with supply chain optimization requirements.
18. Supply Chain Optimization: For each product, provide documentation demonstrating that manufacturer practices comply with supply chain optimization requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

B. Qualification Statements: For Installer.

C. Sample Warranties: For carpet tile.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to [**5**]<**Insert number**> percent of amount installed for each type indicated, but no fewer than 10 full-size units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is certified by the International Certified Floorcovering Installers Association at the [**Commercial II**][**Master II**]<**Insert description**> certification level.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups [**as indicated on Drawings**]<**Insert mockup requirements**> .
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.10 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended in writing by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.11 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent loss of face fiber, edge raveling, snags, and runs.
b. Loss of tuft-bind strength.
c. Excess static discharge.
d. Delamination.
e. Dimensional instability.

3. Warranty Period: [**10**][**15**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILES

A. Carpet Tile :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Bentley Mills, Inc.**]
b. [**Engineered Floors**]
c. [**Interface, Inc.**]
d. [**J&J Flooring Group LLC**]
e. [**Mannington Commercial; a business unit of Mannington Mills, Inc.**]
f. [**Mohawk Group**]
g. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
h. [**StaticSmart; Julie Industries**]
i. [**Tarkett USA**]
j. [**van Gelder, Inc**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bentley Mills, Inc.**]
b. [**Engineered Floors**]
c. [**Interface, Inc.**]
d. [**J&J Flooring Group LLC**]
e. [**Mannington Commercial; a business unit of Mannington Mills, Inc.**]
f. [**Mohawk Group**]
g. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
h. [**StaticSmart; Julie Industries**]
i. [**Tarkett USA**]

j. [**van Gelder, Inc**]
k. <**Insert manufacturer's name**>

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**]<**Insert color**> .
4. Pattern: [**Match Architect's samples**]<**Insert pattern**> .
5. Fiber Content: [**100 percent nylon 6,6**][**100 percent nylon 6**][**100 percent polypropylene**][**100 percent wool**][**80 percent wool; 20 percent nylon 6,6**][**80 percent wool; 20 percent nylon 6**]<**Insert percentage**> .
6. Fiber Type: <**Insert proprietary fiber type**> .
7. Pile Characteristic: [**Level-loop**][**Cut**][**Cut-and-loop**]<**Insert construction**> pile.
8. Yarn Twist: <**Insert TPI (TPCM)**> .
9. Yarn Count: <**Insert count**> .
10. Density: <**Insert oz./cu. yd. (g/cu. cm)**> .
11. Pile Thickness: <**Insert inches (mm)**> for finished carpet tile [**in accordance with ASTM D6859**] .
12. Stitches: <**Insert stitches per inch (mm)**> .
13. Gauge: <**Insert ends per inch (mm)**> .
14. Surface Pile Weight: <**Insert oz./sq. yd. (g/sq. m)**> .
15. Total Weight: <**Insert oz./sq. yd. (g/sq. m)**> for finished carpet tile.
16. Primary Backing/Backcoating: [**Manufacturer's standard composite materials**]<**Insert specific primary backing materials; consult manufacturers**> .
17. Secondary Backing: [**Manufacturer's standard material**]<**Insert specific secondary backing material**> .
18. Backing System: <**Insert proprietary name**> .
19. Size: [**18 by 18 inches (457 by 457 mm)**][**24 by 24 inches (610 by 610 mm)**][**18 by 36 inches (457 by 914 mm)**][**36 by 36 inches (914 by 914 mm)**]<**Insert dimensions**> .
20. Applied Treatments:

    a. Soil-Resistance Treatment: [**Manufacturer's standard treatment**]<**Insert treatment**> .
    b. Antimicrobial Treatment: [**Manufacturer's standard treatment**]<**Insert treatment**> that protects carpet tiles as follows:

        1) Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.

21. Sustainable Design Requirements:

    a. Sustainable Product Certification: [**Silver**][**Gold**][**Platinum**] level certification in accordance with NSF/ANSI 140.
    b. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    c. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
    d. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    e. Extended Producer Responsibility: Provide documentation of manufacturer participation in an extended producer responsibility program.
    f. Life-Cycle Analysis: Provide documentation indicating product contribution to reduction in global warming potential, depletion of the stratospheric ozone layer, acidification of land and water sources, eutrophication, formation of tropospheric ozone, and depletion of

nonrenewable energy resources.

g. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

22. Performance Characteristics:

a. Texture Appearance Retention Rating (TARR): [**Moderate traffic, 2.5**][**Heavy traffic, 3.0**][**Severe traffic, 3.5**]<**Insert number**> minimum in accordance with ASTM D7330.
b. Critical Radiant Flux Classification: Not less than [**0.45 W/sq. cm**][**0.22 W/sq. cm**] in accordance with NFPA 253.
c. Dry Breaking Strength: Not less than **100 lbf (445 N)** in accordance with ASTM D2646.
d. Tuft Bind: Not less than [**3 lbf (13 N)**][**5 lbf (22 N)**][**6.2 lbf (28 N)**][**8 lbf (36 N)**][**10 lbf (45 N)**]<**Insert value**> in accordance with ASTM D1335.
e. Delamination: Not less than [**3.5 lbf/in. (0.6 N/mm)**][**4 lbf/in. (0.7 N/mm)**]<**Insert value**> in accordance with ASTM D3936.
f. Dimensional Tolerance: Within **1/32 inch (0.8 mm)** of specified size dimensions, as determined by physical measurement.
g. Noise Reduction Coefficient (NRC): <**Insert NRC**> in accordance with ASTM C423.
h. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
i. Colorfastness to Light: Not less than 4 after [**40**][**60**]<**Insert number**> AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
j. Electrostatic Propensity: Less than [**3.5**][**2**]<**Insert number**> kV in accordance with AATCC 134.

2.2 ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended in writing by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive types to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and that are recommended in writing by carpet tile manufacturer for releasable installation.

C. Metal Edge/Transition Strips: Extruded aluminum with [**mill**]<**Insert finish**> finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (20 sq. m)**][**1000 sq. ft. (100 sq. m)**]<**Insert area**> , and perform no fewer than three tests in

each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m)**]<**Insert emission**> in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**]<**Insert number**> percent relative humidity level measurement.
c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

D. Wood Subfloors: Verify the following:

1. Underlayment over subfloor complies with requirements specified in Section 061600 "Sheathing."
2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

E. Metal Subfloors: Verify the following:

1. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

F. Painted Subfloors: Perform bond test recommended in writing by adhesive manufacturer. Verify the following:

1. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than [**1/8 inch (3 mm)**]<**Insert dimension**> , protrusions more than **1/32 inch (0.8 mm)**, and substances that may interfere with adhesive bond or show through surface.

G. Access Flooring Systems: Verify the following:

1. Access floor substrate is compatible with carpet tile and adhesive if any.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates.

B. Trowelable Leving and Patching Compounds: Use trowelable leveling and patching compounds in accordance with manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions **1/8 inch (3 mm)** wide or wider, and protrusions more than **1/32 inch (0.8 mm)** unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION OF CARPET TILES

A. General: Comply with CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: [**As recommended in writing by carpet tile manufacturer**][**Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive**][**Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive**][**Free lay; install carpet tiles without adhesive**] .

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns [**indicated on Drawings**][**recommended in writing by carpet tile manufacturer**] .

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING

A. Perform cleaning operations immediately after installing carpet tile as follows:

1. Remove excess adhesive and other surface blemishes using cleaner recommended in writing by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

3.5 PROTECTION

A. Protect installed carpet tile to comply with CRI 104, Section 13.7.

B. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 01 60 91B

SECTION 09 01 60 91C - SHEET CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tufted carpet.
2. Woven carpet.
3. Carpet cushion.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. [**Section 096513 "Resilient Base and Accessories"**][**Section 096519 "Resilient Tile Flooring"**] for resilient wall base and accessories installed with carpet.
3. Section 096813 "Tile Carpeting" for modular carpet tiles.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review methods and procedures related to carpet installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.
d. <**Insert agenda items**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet installation, showing the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
2. Carpet type, color, and dye lot.
3. Locations where dye lot changes occur.
4. Seam locations, types, and methods.
5. Type of subfloor.
6. Type of installation.
7. Pattern type, repeat size, location, direction, and starting point.
8. Pile direction.
9. Type, color, and location of insets and borders.

10. Type, color, and location of edge, transition, and other accessory strips.
11. Transition details to other flooring materials.
12. Type of carpet cushion.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of product.

1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.

D. Samples for Verification: Actual sample of finished products for each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet: **12-inch- (300-mm-)** square Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: **12-inch- (300-mm-)** long Samples.
3. Carpet Cushion: **6-inch- (150-mm-)** square Sample.
4. Carpet Seam: **6-inch (150-mm)** Sample.
5. Mitered Carpet-Border Seam: **12-inch- (300-mm-)** square Sample. Show carpet pattern alignment.

E. Product Schedule: For carpet[**and carpet cushion**]. Use same designations indicated on Drawings.

F. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Health Product Declaration (HPD): Provide product's Material Health Certificate or Cradle to Cradle certification.
6. Declare, Action Submittals: Provide product's Declare product label, designated as "Red List Free," Declare or Living Building Challenge (LBC) compliant to 0.1 percent.
7. Environmental Product Declaration: For each product.
8. Health Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Environmental Product Declaration: For each product.
11. Environmental Product Declaration: For each product.
12. Third-Party Certifications: For each product.
13. Third-Party Certified Life Cycle Assessment: For each product.
14. Facts, Action Submittals: Provide product's Facts - NSF/ANSI 336, "Sustainability Assessment for Commercial Furnishings Fabric," certification.
15. Health Product Declaration (HPD): For each product.
16. Health Product Declaration (HPD): Provide HPD.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For carpet[**and carpet cushion**], for tests performed by a qualified testing agency.

B. Qualification Statements: For Installer.

C. Sample Warranties: For sheet carpeting.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet. Include the following:

1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet[**and carpet cushion**].

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet: Full-width rolls equal to [**5**]<**Insert number**> percent of amount installed for each type indicated, but not less than **10 sq. yd.** **(8.3 sq. m)**.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is certified by the International Certified Floorcovering Installers Association at the [**Commercial II**][**Master II**]<**Insert description**> certification level.

1.8 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups [**as indicated on Drawings**]<**Insert mockup requirements**>.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

B. Deliver carpet in original mill protective covering with mill register numbers and tags attached.

1.10 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet[**and carpet cushion**] until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet[**and carpet cushion**] over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended in writing by carpet manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.11 WARRANTY

A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

    a. More than 10 percent loss of face fiber, edge raveling, snags, and runs.
    b. Loss of tuft-bind strength.
    c. Excess static discharge.
    d. Delamination.

3. Warranty Period: [**10**][**15**]<**Insert number**> years from date of Substantial Completion.

B. Special Warranty for Carpet Cushion: Manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.

1. Warranty includes removal and replacement of carpet and accessories required by replacement of carpet cushion.
2. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse.
3. Failure includes, but is not limited to, permanent indentation or compression.
4. Warranty Period: [**10**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUFTED CARPET

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Beaulieu International Group**]
2. [**Bentley Mills, Inc.**]

3. [**Couristan, Inc.**]
4. [**Interface, Inc.**]
5. [**J&J Flooring Group LLC**]
6. [**Mannington Commercial; a business unit of Mannington Mills, Inc.**]
7. [**Mohawk Carpet, LLC; The Mohawk Group**]
8. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
9. [**Tarkett USA**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Beaulieu International Group**]
2. [**Bentley Mills, Inc.**]
3. [**Couristan, Inc.**]
4. [**Interface, Inc.**]
5. [**J&J Flooring Group LLC**]
6. [**Mannington Commercial; a business unit of Mannington Mills, Inc.**]
7. [**Mohawk Carpet, LLC; The Mohawk Group**]
8. [**Shaw Industries Group, Inc.; Berkshire Hathaway Company**]
9. [**Tarkett USA**]
10. <**Insert manufacturer's name**>

C. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

D. Pattern: [**Match Architect's samples**]<**Insert pattern**>.

E. Fiber Content: [**100 percent nylon 6,6**][**100 percent nylon 6**][**100 percent polypropylene**]<**Insert fiber and content by percentage**>.

F. Fiber Type: <**Insert proprietary fiber type**>.

G. Pile Characteristic: [**Level-loop**][**Cut**][**Cut-and-loop**][**Multilevel-loop**][**Level tip shear**][**Random shear**][**Frieze**][**Sculptured**]<**Insert characteristic**> pile.

H. Yarn Twist: <**Insert twist in TPI (TPCM)**>.

I. Yarn Count: <**Insert yarn count**>.

J. Density: <**Insert oz./cu. yd. (g/cu. cm)**>.

K. Pile Thickness: <**Insert inches (mm)**> for finished carpet[**in accordance with ASTM D6859**].

L. Stitches: <**Insert stitches per inch (mm)**>.

M. Gage: <**Insert gage in ends per inch (mm)**>.

N. Face Weight: <**Insert oz./sq. yd. (g/sq. m)**>.

O. Total Weight: <**Insert oz./sq. yd. (g/sq. m)**> for finished carpet.

P. Primary Backing: [**Manufacturer's standard material**][**Woven polypropylene**][**Nonwoven, polypropylene or polyester**]<**Insert specific primary backing material**>.

Q. Secondary Backing: [**Manufacturer's standard material**][**Woven polypropylene**][**Nonwoven, polypropylene or polyester**][**Woven jute**][**Fiberglass**]<**Insert specific secondary backing material**>.

R. Backcoating: [**Manufacturer's standard material**][**SBR latex**]<**Insert backcoating; consult manufacturers**>.

S. Backing System: <**Insert proprietary name**>.

T. Roll Width: [**12 ft. (3.7 m)**][**6 ft. (1.8 m)**][**13.5 ft. (4.1 m)**][**15 ft. (4.6 m)**]<**Insert dimension**>.

U. Applied Treatments:

1. Applied Soil-Resistance Treatment: [**Manufacturer's standard material**]<**Insert treatment**>.
2. Antimicrobial Treatment: [**Manufacturer's standard material**]<**Insert treatment**>.

    a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.

V. Sustainable Design Requirements:

1. Sustainable Product Certification: [**Silver**][**Gold**][**Platinum**] level certification in accordance with NSF/ANSI 140.
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Verify Adhesives have a VOC content of [**50**]<**Insert number**> g/L or less.
6. Extended Producer Responsibility: Provide documentation of manufacturer participation in an extended producer responsibility program.
7. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

W. Performance Characteristics:

1. Texture Appearance Retention Rating (TARR): [**Moderate traffic, 2.5**][**Heavy traffic, 3.0**][**Severe traffic, 3.5**]<**Insert number**> minimum in accordance with ASTM D7330.
2. Critical Radiant Flux Classification: Not less than [**0.45 W/sq. cm**][**0.22 W/sq. cm**] in accordance with NFPA 253.
3. Dry Breaking Strength: Not less than **100 lbf (445 N)** in accordance with ASTM D2646.
4. Tuft Bind: Not less than [**3 lbf (13 N)**][**5 lbf (22 N)**][**6.2 lbf (28 N)**][**8 lbf (36 N)**][**10 lbf (45 N)**]<**Insert value**> in accordance with ASTM D1335.
5. Delamination: Not less than [**2.5 lbf/in. (0.4 N/mm)**][**3.5 lbf/in. (0.6 N/mm)**][**4 lbf/in. (0.7 N/mm)**]<**Insert value**> in accordance with ASTM D3936.
6. Noise Reduction Coefficient (NRC): <**Insert NRC**> in accordance with ASTM C423.
7. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
8. Colorfastness to Light: Not less than 4 after [**40**][**60**]<**Insert number**> AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.

9. Electrostatic Propensity: Less than [**3.5**][**2**]<**Insert number**> kV in accordance with AATCC 134.

2.2 WOVEN CARPET

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Axminster Carpets**]
2. [**Bentley Mills, Inc.**]
3. [**Bloomsburg Carpet Industries, Inc.**]
4. [**Couristan, Inc.**]
5. [**Langhorne Carpet Company**]
6. [**Mohawk Carpet, LLC; The Mohawk Group**]
7. [**Prestige Mills, Inc.**]
8. [**Stanton Carpet Corporation**]
9. [**Tarkett USA**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Axminster Carpets**]
2. [**Bentley Mills, Inc.**]
3. [**Bloomsburg Carpet Industries, Inc.**]
4. [**Couristan, Inc.**]
5. [**Langhorne Carpet Company**]
6. [**Mohawk Carpet, LLC; The Mohawk Group**]
7. [**Prestige Mills, Inc.**]
8. [**Stanton Carpet Corporation**]
9. [**Tarkett USA**]
10. <**Insert manufacturer's name**>

C. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

D. Pattern: [**Match Architect's samples**]<**Insert pattern**>.

E. Fiber Content: [**100 percent wool**][**80 percent wool; 20 percent nylon 6,6**][**80 percent wool; 20 percent nylon 6**]<**Insert fiber and content by percentage**>.

F. Face Construction: [**Axminster**][**Wilton**][**Velvet**]<**Insert construction**>.

G. Pile Characteristic: [**Level-loop**][**Cut**][**Cut-and-loop**] pile.

H. Yarn Twist: <**Insert twist in TPI (TPCM)**>.

I. Yarn Count: <**Insert yarn count**>.

J. Density: <**Insert oz./cu. yd. (g/cu. cm)**>.

K. Pile Thickness: <**Insert inches (mm)**> for finished carpet[**in accordance with ASTM D6859**].

L. Rows: <**Insert number of lengthwise tufts per inch (mm)**>.

M. Pitch: <**Insert number of rows in 27 inches (686 mm)**>.

N. Face Weight: <**Insert oz./sq. yd. (g/sq. m)**>.

O. Total Weight: <**Insert oz./sq. yd. (g/sq. m)**> for finished carpet.

P. Backing: [**Manufacturer's standard.**][**As follows:**]

1. Chain Warp: <**Insert material**>.
2. Stuffer Warp: <**Insert material**>.
3. Shot or Fill Weft: <**Insert material**>.
4. Backcoating: <**Insert backcoating**>.

Q. Applied Treatments:

1. Applied Soil-Resistance Treatment: [**Manufacturer's standard material**]<**Insert treatment**>.
2. Antimicrobial Treatment: [**Manufacturer's standard material**]<**Insert treatment**>.

a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.

R. Sustainable Design Requirements:

1. Sustainable Product Certification: [**Silver**][**Gold**][**Platinum**] level certification in accordance with NSF/ANSI 140.
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Extended Producer Responsibility: Provide documentation of manufacturer participation in an extended producer responsibility program.
6. Life-Cycle Analysis: Provide documentation indicating product contribution to reduction in global warming potential, depletion of the stratospheric ozone layer, acidification of land and water sources, eutrophication, formation of tropospheric ozone, and depletion of nonrenewable energy resources.
7. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

S. Performance Characteristics:

1. Texture Appearance Retention Rating (TARR): [**Moderate traffic, 2.5**][**Heavy traffic, 3.0**][**Severe traffic, 3.5**]<**Insert number**> minimum in accordance with ASTM D7330.
2. Critical Radiant Flux Classification: Not less than [**0.45 W/sq. cm**][**0.22 W/sq. cm**] in accordance with NFPA 253.
3. Dry Breaking Strength: Not less than **100 lbf (445 N)** in accordance with ASTM D2646.
4. Noise Reduction Coefficient (NRC): <**Insert NRC**> in accordance with ASTM C423.
5. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
6. Colorfastness to Light: Not less than 4 after [**40**][**60**]<**Insert number**> AFU (AATCC fading units)

in accordance with AATCC 16.3 Option 3.

7. Electrostatic Propensity: Less than [**3.5**][**2**]<**Insert number**> kV in accordance with AATCC 134.

2.3 CARPET CUSHION

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Carpenter Co.**]
2. [**Dalton Foam; Barnhardt Manufacturing Company**]
3. [**Dura Undercushions Ltd.**]
4. [**Foam Products Corporation**]
5. [**TredMOR by SCI; Leggett & Platt, Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Carpenter Co.**]
2. [**Dalton Foam; Barnhardt Manufacturing Company**]
3. [**Dura Undercushions Ltd.**]
4. [**Foam Products Corporation**]
5. [**TredMOR by SCI; Leggett & Platt, Inc.**]
6. <**Insert manufacturer's name**>

C. Traffic Classification: Carpet Cushion Council's [**Class I, moderate**][**Class II, heavy**][**Class III, extra-heavy**] traffic.

D. Fiber Cushion: [**Rubberized hair, mothproofed and sterilized**][**Rubberized jute, mothproofed and sterilized**][**Synthetic**][**Resinated, recycled textile**].

1. Weight: <**Insert oz./sq. yd. (g/sq. m)**>.
2. Thickness: <**Insert inches (mm)**> plus 5 percent maximum.
3. Density: <**Insert lb/cu. ft. (kg/cu. m)**>.

E. Rubber Cushion: [**Flat**][**Rippled waffle**][**Textured flat**][**Reinforced**].

1. Weight: <**Insert oz./sq. yd. (g/sq. m)**>.
2. Thickness: <**Insert inches (mm)**> plus 5 percent maximum.
3. Compression Resistance: <**Insert lb/sq. in. (kg/sq. mm)**> at [**25**][**65**] percent in accordance with ASTM D3676.
4. Density: <**Insert lb/cu. ft. (kg/cu. m)**>.

F. Polyurethane-Foam Cushion: [**Grafted prime**][**Densified**][**Bonded**][**Mechanically frothed**].

1. Compression Force Deflection at 65 Percent: <**Insert lb/sq. in. (kg/sq. mm) of polymer density**> in accordance with ASTM D3574.
2. Thickness: <**Insert inches (mm)**>.
3. Density: <**Insert lb/cu. ft. (kg/cu. m)**>.

G. Performance Characteristics:

1. Critical Radiant Flux Classification: Not less than [**0.45 W/sq. cm**][**0.22 W/sq. cm**] in accordance with NFPA 253.

2. Noise Reduction Coefficient (NRC): <**Insert NRC**> in accordance with ASTM C423.

H. Sustainable Design Requirements:

1. Sustainable Product Certification: [**Silver**][**Gold**][**Platinum**] level certification in accordance with NSF/ANSI 140.
2. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
4. Verify flooring products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended in writing by [**carpet**][**carpet cushion**] manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining types to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet and that are recommended in writing or provided by [**carpet manufacturer**][**carpet and carpet cushion manufacturers**].

C. Tackless Carpet Stripping: Water-resistant plywood, in strips as required to match cushion thickness and that comply with CRI 104.

D. Seam Adhesive: Hot-melt adhesive tape or similar product recommended in writing by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

E. Metal Edge/Transition Strips: Extruded aluminum with [**mill**]<**Insert finish**> finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance.

B. Examine carpet for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft.**

(20 sq. m)][1000 sq. ft. (100 sq. m)]<**Insert area**>, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [**3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m)**]<**Insert emission**> in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [**75**]<**Insert number**> percent relative humidity level measurement.
c. Perform additional moisture tests recommended in writing by [**adhesive and carpet**][**adhesive, carpet cushion, and carpet**] manufacturers. Proceed with installation only after substrates pass testing.

D. Wood Subfloors: Verify the following:

1. Underlayment over subfloor complies with requirements specified in Section 061600 "Sheathing."
2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104 and with carpet manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, in accordance with manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions **1/8 inch (3 mm)** wide or wider, and protrusions more than **1/32 inch (0.8 mm)**, unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by [**adhesive and carpet**][**adhesive, carpet, and carpet cushion**] manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

A. Comply with CRI 104 and [**carpet manufacturer's**][**carpet and carpet cushion manufacturers'**] written installation instructions for the following:

1. Direct-glue-down installation.
2. Double-glue-down installation.
3. Carpet with attached-cushion installation.
4. Preapplied adhesive installation.
5. Hook-and-loop installation.
6. Stretch-in installation.
7. Stair installation.

B. Comply with carpet manufacturer's written instructions and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

1. Stretch-in Carpet Installation: Install carpet cushion seams at 90-degree angle with carpet seams.

C. Install [**pattern parallel to walls and borders**][**as indicated on Drawings**]<**Insert requirements**>.

D. Install borders with mitered corner seams.

E. Do not bridge building expansion joints with carpet.

F. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet manufacturer.

G. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use nonpermanent, nonstaining marking device.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended in writing by carpet manufacturer.
2. Remove yarns that protrude from carpet surface.
3. Vacuum carpet using commercial machine with face-beater element.

B. Protect installed carpet to comply with CRI 104, Section 13.7.

C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer [**and carpet cushion manufacturer**][**and carpet adhesive manufacturer**][**and carpet cushion and adhesive manufacturers**].

END OF SECTION 09 01 60 91C

Task	Specification	Specification Description
09 01 60 91	01 22 00 00	No Specification Required
09 01 60 91	07 92 00 00	Joint Sealants

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SECTION 09 01 90 52 - MAINTENANCE OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bonding agents.
2. Patching mortar.
3. Preplaced concrete materials.
4. Joint filler.
5. Epoxy crack-injection materials.
6. Corrosion-inhibiting materials.
7. Polymer-overlay materials.
8. Polymer-sealer materials.
9. Composite reinforcement materials.

1.2 ALLOWANCES

A. Allowances for maintenance of cast-in-place concrete are specified in Section 012100 "Allowances."

B. Field quality-control testing is part of testing and inspecting allowance.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1. Unit prices apply to authorized work covered by [**quantity allowances**][**estimated quantities**].
2. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.

B. General: Unit prices include the cost of preparing existing construction to receive the Work indicated[**and costs of field quality control required for units of Work completed**].

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**].

1. Review methods and procedures related to concrete work, including, but not limited to, the following:

a. Verify concrete-maintenance specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Concrete restoration specialist.
c. Materials, material application, sequencing, tolerances, and required clearances.
d. Shoring and bracing.
e. Quality-control program.
f. Coordination with building occupants.

1.5 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, chemical composition, physical properties, test data, and mixing, preparation, project application types consisting of horizontal, vertical or overhead locations and application instructions.

B. Shop Drawings:

1. Shoring and Bracing: Provide Drawings or documentation to ensure that structure and temporary supports withstand the anticipated loads during construction and the effect of demolition on the capacity of the structure. Submit design calculations, sealed by an engineer licensed in state of Project, for shoring and bracing where required by the extent of structural repairs or removal of deteriorated concrete and subsequent replacement.

C. Samples: Cured Samples for each exposed product and for each color and texture specified, [**in manufacturer's standard size appropriate for each type of work**].

D. Samples for Initial Selection: Cured Samples for each exposed product and for each color and texture.

1. Include sets of patching-material Samples in the form of briquettes, at least [**3 inches (75 mm) long by 1-1/2 inches (38 mm) wide**] representative of the range of concrete colors on the building. Document each Sample with product, mix, and/or other information necessary to replicate it.
2. Include sets of Samples for epoxy crack-injection adhesive and capping adhesive in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.
3. Include sets of polymer-overlay Samples in the form of treated cementitious tiles at least [**4 inches (100 mm) long by 4 inches (100 mm) wide**] representative of the range of required colors and textures.
4. Include sets of polymer-sealer Samples in the form of treated cementitious tiles at least [**4 inches (100 mm) long by 4 inches (100 mm) wide**] representative of the range of required colors and textures.
5. Have each set of Samples contain a close color range of at least [**three**][**six**] Samples of different mixes of materials that match the variations in existing, adjacent concrete when cured and dry.

E. Samples for Verification: Cured Samples for each exposed product and for each color and texture specified.

1. Include Samples of each required type, color, and texture of patching material in the form of patches in drilled holes or sawed joints in sample concrete representative of the range of concrete colors on the building.
2. Include Samples of epoxy crack-injection adhesive in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.
3. Include Samples of each required type, color, and texture of polymer-overlay material in the form of cementitious tiles at least [**8 inches (200 mm) long by 8 inches (200 mm) wide**].
4. Include Samples of each required type, color, and texture of polymer-sealer material in the form of cementitious tiles at least [**8 inches (200 mm) long by 8 inches (200 mm) wide**].

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**concrete-maintenance specialist**][**and**][**manufacturers**].

B. Material Certificates: For each type of [**portland cement**][**aggregate**] supplied for mixing or adding to products at Project site.

C. Product Test Reports: For each [**manufactured bonding agent**][**cementitious patching mortar**][**joint filler**][**crack-injection adhesive**][**polymer overlay**][**polymer sealer**][**and**][**composite structural reinforcement**], for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

E. Quality-Control Program: Submit before work begins.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Each [**manufactured bonding-agent**][**packaged patching-mortar**][**joint-filler**][**crack-injection-adhesive**][**corrosion-inhibiting-treatment**][**polymer-overlay**][**polymer-sealer**][**and**][**composite-structural-reinforcement**] manufacturer must employ factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.

B. Concrete-Maintenance Specialist Qualifications: Engage an experienced concrete-maintenance firm that employs installers and supervisors who are trained and approved by manufacturer to apply [**packaged patching-mortar**][**crack-injection adhesive**][**corrosion-inhibiting treatments**][**polymer overlays**][**polymer sealers**][**and**][**composite structural reinforcement**] when performing the Work of this Section. Firm must have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing or patching new concrete is insufficient experience for concrete-maintenance work.

1. Field Supervision: Concrete-maintenance specialist firm must maintain experienced full-time supervisors on Project site during times that concrete-maintenance work is in progress.

C. Quality-Control Program: Prepare a written plan for concrete maintenance to systematically demonstrate the ability of personnel to properly perform maintenance work, including each phase or process, protection of surrounding materials during operations, and control of debris and runoff during the Work. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.

D. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1.8 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Concrete Removal and Patching Mockup: Remove and repair an [**approximately 50 sq. ft. (4.6 sq. m)**][**approximately 100 sq. in. (645 sq. cm)**] area of [**deteriorated concrete deck**][**deteriorated concrete wall**].
2. Floor Joint Repair Mockup: Cut out and reinstall joints in two separate areas [**, each approximately 48 inches (1200 mm) long**][**as indicated on Drawings**].
3. Epoxy Crack Injection Mockup: Perform epoxy crack-injection material in two separate areas [**,**

each approximately 48 inches (1200 mm) long][as indicated on Drawings].

4. Polymer-Overlay Mockup: Apply an [**approximately 50 sq. ft. (4.6 sq. m)**] area of polymer overlay.
5. Polymer Sealer Mockup: Apply an [**approximately 50 sq. ft. (4.6 sq. m)**] area of polymer sealer.
6. Composite Structural-Reinforcement Mockup: Apply composite structural reinforcement [**a minimum of 48 inches (1200 mm) long][as indicated on Drawings**].
7. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
8. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.

B. Store cementitious materials off the ground, under cover, and in a dry location.

C. Store aggregates covered and in a dry location; maintain grading and other required characteristics and prevent contamination.

1.10 FIELD CONDITIONS

A. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

1. Use only Class A epoxies when substrate temperatures are below or are expected to go below **40 deg F (5 deg C)** within eight hours.
2. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below **60 deg F (16 deg C)** within eight hours.
3. Use only Class C epoxies when substrate temperatures are above and are expected to stay above **60 deg F (16 deg C)** for eight hours.

B. Cold-Weather Requirements for Cementitious Materials:

1. Do not apply unless concrete surface and air temperatures are above **40 deg F (5 deg C)** and will remain so for at least 48 hours after completion of Work.
2. Comply with the following procedures:

    a. When air temperature is below **40 deg F (5 deg C)**, heat patching-material ingredients and existing concrete to produce temperatures between **40 and 90 deg F (5 and 32 deg C)**.
    b. When mean daily air temperature is between **25 and 40 deg F (minus 4 and plus 5 deg C)**, cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above **32 deg F (0 deg C)** within the enclosure for 48 hours after repair.
    c. When mean daily air temperature is below **25 deg F (minus 4 deg C)**, provide enclosure and heat to maintain temperatures above **32 deg F (0 deg C)** within the enclosure for 48 hours after repair.

C. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial

shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of **90 deg F (32 deg C)** and above.

D. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below **55 deg F (13 deg C)** or above [**75 deg F (24 deg C)**][**90 deg F (32 deg C)**]. Apply only to [**dry substrates**][**substrates that have been dry for at least 72 hours**].

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

2.2 BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Manufactured product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARDEX Americas**]
    b. [**Dayton Superior Corporation**]
    c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    d. [**Kaufman Products, Inc**]
    e. [**MAPEI Corporation**]
    f. [**Master Builders Solutions**]
    g. [**Sika Corporation**]
    h. [**SpecChem, LLC**]
    i. [**Sto Corp.**]

B. Epoxy Bonding Agent: ASTM C881/C881M [**Type II**][**Type V**] bonding system, free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Abatron, Inc**]
    b. [**ChemCo Systems, Inc.**]
    c. [**Dayton Superior Corporation**]
    d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    e. [**Kaufman Products, Inc**]
    f. [**MAPEI Corporation**]
    g. [**Master Builders Solutions**]
    h. [**Sika Corporation**]

i. [**Sto Corp.**]
j. [**US SPEC, Division of US MIX Company**]
k. [**Xypex Chemical Corporation**]

C. Latex Bonding Agent, Redispersible: Type I, ASTM C1059/C1059M[**for use at nonstructural and interior locations unless otherwise indicated**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Dayton Superior Corporation**]
b. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
c. [**Kaufman Products, Inc**]
d. [**US SPEC, Division of US MIX Company**]
e. [**W. R. Meadows, Inc**]

D. Latex Bonding Agent, Nonredispersible: Type II, ASTM C1059/C1059M[**for use at structural and exterior locations and where indicated**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemMasters, Inc**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**MAPEI Corporation**]
f. [**US SPEC, Division of US MIX Company**]
g. [**W. R. Meadows, Inc**]

E. Mortar Scrub Coat: Mix consisting of 1 part portland cement and 1 part fine aggregate complying with ASTM C144, except 100 percent passing a **No. 16 (1.18-mm)** sieve.

2.3 PATCHING MORTAR

A. Patching Mortar Requirements:

1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
2. Color and Aggregate Texture: Provide patching mortar and aggregates of colors and sizes necessary to produce patching mortar[**where indicated**] that matches existing, adjacent, and exposed concrete. Blend several aggregates if necessary to achieve suitable matches.
3. Coarse Aggregate for Patching Mortar: ASTM C33/C33M, Size No. 8, Class 5S washed aggregate. Add to patching-mortar mix only as permitted by patching-mortar manufacturer.

B. Job-Mixed Patching Mortar : 1 part portland cement and 2-1/2 parts fine aggregate complying with ASTM C144, except 100 percent passing a **No. 16 (1.18-mm)** sieve.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CGM, Incorporated**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**KOSTER American Corporation**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Sika Corporation**]
j. [**Simpson Strong-Tie Co., Inc.**]
k. [**Sto Corp.**]
l. [**Tnemec Company, Inc.**]
m. [**US SPEC, Division of US MIX Company**]
n. [**W. R. Meadows, Inc**]

C. Cementitious Patching Mortar : Packaged, dry mix for repair of concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CGM, Incorporated**]
b. [**ChemMasters, Inc**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
e. [**Kaufman Products, Inc**]
f. [**KOSTER American Corporation**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Schonox HPS North America, Inc.**]
j. [**Sika Corporation**]
k. [**Simpson Strong-Tie Co., Inc.**]
l. [**Sto Corp.**]
m. [**Tnemec Company, Inc.**]
n. [**United Gilsonite Laboratories (UGL)**]
o. [**US SPEC, Division of US MIX Company**]
p. [**W. R. Meadows, Inc**]
q. [**Xypex Chemical Corporation**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

D. Rapid-Strengthening, Cementitious Patching Mortar : [**ASTM C928/C928M**] packaged, dry mix for repair of concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARDEX Americas**]
    b. [**CGM, Incorporated**]
    c. [**ChemMasters, Inc**]
    d. [**Dayton Superior Corporation**]
    e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    f. [**Kaufman Products, Inc**]
    g. [**MAPEI Corporation**]
    h. [**Master Builders Solutions**]
    i. [**Schonox HPS North America, Inc.**]
    j. [**Sika Corporation**]
    k. [**Simpson Strong-Tie Co., Inc.**]
    l. [**Sto Corp.**]
    m. [**US SPEC, Division of US MIX Company**]
    n. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**1000 psi (7.0 MPa)**][**2000 psi (13.8 MPa)**][**3000 psi (21.0 MPa)**][**4000 psi (27.6 MPa)**] within [**three**] hours when tested in accordance with ASTM C109/C109M.

E. Polymer-Modified, Cementitious Patching Mortar : Packaged, dry mix for repair of concrete and that contains a[**nonredispersible**] latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AQUAFIN, Inc**]
    b. [**ARDEX Americas**]
    c. [**CGM, Incorporated**]
    d. [**ChemMasters, Inc**]
    e. [**Cortec Corporation**]
    f. [**Dayton Superior Corporation**]
    g. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
    h. [**Kaufman Products, Inc**]
    i. [**MAPEI Corporation**]
    j. [**Master Builders Solutions**]
    k. [**Schonox HPS North America, Inc.**]
    l. [**Sika Corporation**]
    m. [**Simpson Strong-Tie Co., Inc.**]
    n. [**Sto Corp.**]
    o. [**United Gilsonite Laboratories (UGL)**]
    p. [**US SPEC, Division of US MIX Company**]
    q. [**Uzin Utz North America, Inc.**]
    r. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

F. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar : Packaged, dry mix for repair of concrete and that contains silica fume complying with ASTM C1240 and a[**nonredispersible**] latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AQUAFIN, Inc**]
b. [**CGM, Incorporated**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]
g. [**Simpson Strong-Tie Co., Inc.**]
h. [**Sto Corp.**]
i. [**W. R. Meadows, Inc**]

2. Compressive Strength: Not less than [**4000 psi (27.6 MPa)**][**5000 psi (34.5 MPa)**][**6000 psi (41.4 MPa)**] at [**28 days**] when tested in accordance with ASTM C109/C109M.

2.4 PREPLACED CONCRETE MATERIALS

A. Preplaced Aggregate: Washed aggregate, ASTM C33/C33M, Class 5S, with [**95 to 100 percent passing a 1-1/2-inch (38-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, zero to 10 percent passing a 1/2-inch (12.7-mm) sieve, and zero to 2 percent passing a 3/8-inch (9.5-mm) sieve**][**100 percent passing a 1-1/2-inch (38-mm) sieve, 95 to 100 percent passing a 1-inch (25-mm) sieve, 40 to 80 percent passing a 3/4-inch (19-mm) sieve, zero to 15 percent passing a 1/2-inch (12.7-mm) sieve, and zero to 2 percent passing a 3/8-inch (9.5-mm) sieve**].

B. Fine Aggregate for Grout: Fine aggregate in accordance with ASTM C33/C33M, but with 100 percent passing a **No. 8 (2.36-mm)** sieve, 95 to 100 percent passing a **No. 16 (1.18-mm)** sieve, 55 to 80 percent passing a **No. 30 (0.6-mm)** sieve, 30 to 55 percent passing a **No. 50 (0.3-mm)** sieve, 10 to 30 percent passing a **No. 100 (0.15-mm)** sieve, zero to 10 percent passing a **No. 200 (0.075-mm)** sieve, and having a fineness modulus of 1.30 to 2.10.

C. Grout Fluidifier for Grout: ASTM C937.

D. Pozzolans for Grout: ASTM C618.

2.5 JOINT FILLER

A. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A durometer hardness of at least 80 in accordance with ASTM D2240.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**SIMIRON Inc.**]
b. [**Abatron, Inc**]
c. [**ChemCo Systems, Inc.**]
d. [**Dayton Superior Corporation**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**Kaufman Products, Inc**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Metzger/McGuire**]
j. [**Sika Corporation**]

B. Polyurea Joint Filler: Two-component, semirigid, 100 percent solids, polyurea resin with a Shore A durometer hardness of at least 80 in accordance with ASTM D2240.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SIMIRON Inc.**]
b. [**ARDEX Americas**]
c. [**ASTC Global, Inc.**]
d. [**ChemCo Systems, Inc.**]
e. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
f. [**HTS Chemical; Hi-Tech Systems**]
g. [**Kaufman Products, Inc**]
h. [**Master Builders Solutions**]
i. [**Metzger/McGuire**]
j. [**SpecChem, LLC**]
k. [**US SPEC, Division of US MIX Company**]

C. Color: [**As indicated by manufacturer's designations**][**Matching existing joint filler**][**As selected by Architect from full range of industry colors**].

2.6 EPOXY CRACK-INJECTION MATERIALS

A. Epoxy Crack-Injection Adhesive: ASTM C881/C881M, bonding system [**Type I,**][**Type IV,**][**Type IV at structural locations and where indicated, Type I at other locations;**] free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Abatron, Inc**]
b. [**ChemCo Systems, Inc.**]
c. [**Dayton Superior Corporation**]
d. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]

e. [**Fyfe Co. LLC**]
f. [**Kaufman Products, Inc**]
g. [**MAPEI Corporation**]
h. [**Master Builders Solutions**]
i. [**Sika Corporation**]
j. [**Sto Corp.**]
k. [**US SPEC, Division of US MIX Company**]
l. [**W. R. Meadows, Inc**]

2. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.
3. Color: Provide epoxy crack-injection adhesive and capping adhesive [**as indicated by manufacturer's designations**][**that blend with existing, adjacent concrete and do not stain concrete surface**][**As selected by Architect from full range of industry colors**].

2.7 CORROSION-INHIBITING MATERIALS

A. Corrosion-Inhibiting Treatment: Waterborne solution of alkaline corrosion-inhibiting chemicals for concrete-surface application that penetrates concrete by diffusion and forms a protective film on steel reinforcement.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Cortec Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

2.8 POLYMER-OVERLAY MATERIALS

A. Polymer Overlay: Epoxy adhesive complying with ASTM C881/C881M, bonding system Type III, with surface-applied aggregate for skid resistance; free of VOCs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemCo Systems, Inc.**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**Kaufman Products, Inc**]
e. [**MAPEI Corporation**]
f. [**Master Builders Solutions**]
g. [**Sika Corporation**]
h. [**Sto Corp.**]

i. [**US SPEC, Division of US MIX Company**]

2. Aggregate: ACI 503.3, oven-dried, washed silica sand.
3. Color and Texture: [**As indicated by manufacturer's designations**][**Matching existing**][**As selected by Architect from full range of industry colors**].

2.9 POLYMER-SEALER MATERIALS

A. Epoxy Polymer Sealer: Low-viscosity epoxy, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; [**free of VOCs**][**VOC content 100 g/L or less**][**VOC content 400 g/L or less**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ChemCo Systems, Inc.**]
b. [**Dayton Superior Corporation**]
c. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
d. [**MAPEI Corporation**]
e. [**Master Builders Solutions**]
f. [**Sika Corporation**]

2. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from full range of industry colors**].

B. Methacrylate Polymer Sealer: Low-viscosity, high-molecular-weight methacrylate, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; [**free of VOCs**][**VOC content 100 g/L or less**][**VOC content 400 g/L or less**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SIMIRON Inc.**]
b. [**Kwik Bond Polymers**]
c. [**Master Builders Solutions**]
d. [**Sika Corporation**]
e. [**Transpo Industries, Inc.**]

2. Color: [**As indicated by manufacturer's designations**][**As selected by Architect from full range of industry colors**].

2.10 COMPOSITE REINFORCEMENT MATERIALS

A. Composite Structural Reinforcement: Manufacturer's system consisting of [**carbon-fiber**][**or**][**glass-fiber**] reinforcement in the form of [**tow sheet with field-applied saturant**][**or**][**preimpregnated sheet**]

and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as externally bonded structural reinforcement for concrete.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Fyfe Co. LLC**]
    b. [**MAPEI Corporation**]
    c. [**Master Builders Solutions**]
    d. [**Schonox HPS North America, Inc.**]
    e. [**Sika Corporation**]

2.11 MISCELLANEOUS MATERIALS

A. Curing Materials: For ready-mixed concrete or packaged repair materials.

B. Formwork Materials: Form-facing materials must comply with **ACI 301 (ACI 301M)** requirements.

C. Water: Potable.

D. Cleaning Agent: Commercial muriatic acid solution.

2.12 MIXES

A. General: Mix products, in clean containers, in accordance with manufacturer's written instructions.

1. Do not add water, thinners, or additives unless recommended by manufacturer.
2. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
3. Do not mix more materials than can be used within time limits recommended by manufacturer. Discard materials that have begun to set.

B. Mortar Scrub Coat: Mix dry ingredients with enough water to provide consistency of thick cream.

C. Dry-Pack Mortar: Mix required type(s) of patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

D. Concrete Materials: Comply with [**Section 033000 "Cast-in-Place Concrete."**][**Section 033300 "Architectural Concrete."**]

E. Concrete Mixture Materials: Ready mixed.

1. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless modified by requirements in the Contract Documents.
2. Portland Cement: ASTM C150/C150M, Type I, II, or III unless otherwise indicated.
3. Fly Ash: ASTM C618, Class C or F.
4. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
5. Silica Fume: ASTM C1240 amorphous silica.

6. Aggregates: ASTM C330/C330M, nominal maximum aggregate size, gradation and types appropriate for the dimension of the repair area and project application.
7. Air-Entraining Admixture: ASTM C260/C260M.
8. Chemical Admixtures: Certified and as recommended by manufacturer for project applications to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

F. Repair Underlayment:

1. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/8 inch** and that can be feathered at edges to match adjacent floor elevations.
2. Compressive Strength: Not less than [**4100 psi (29 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

G. Repair Overlayment:

1. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/4 inch (6 mm)** and that can be filled in over a scarified surface to match adjacent floor elevations.
2. Compressive Strength: Not less than [**5000 psi (34.5 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.

H. Grout for Use with Preplaced Aggregate: Proportion in accordance with ASTM C938. Add grout fluidifier to mixing water followed by portland cement, pozzolan, and fine aggregate.

PART 3 - EXECUTION

3.1 CONCRETE MAINTENANCE

A. Have concrete-maintenance work performed only by qualified concrete-maintenance specialist.

B. Comply with manufacturers' written instructions for surface preparation and product application.

3.2 EXAMINATION

A. Notify Architect seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.

B. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls, make boundaries level and plumb unless otherwise indicated.

C. Pachometer Testing: Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

D. Perform surveys as the Work progresses to detect hazards resulting from concrete-maintenance work.

3.3 PREPARATION

A. Ensure that supervisory personnel are on-site and on duty when concrete-maintenance work begins and during its progress.

B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, plants, and surrounding buildings from harm resulting from concrete-maintenance work.

1. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
2. Use only proven protection methods appropriate to each area and surface being protected.
3. Provide temporary barricades, barriers, and directional signage to exclude public from areas where concrete-maintenance work is being performed.
4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of concrete-maintenance work.
5. Contain dust and debris generated by concrete-maintenance work and prevent it from reaching the public or adjacent surfaces.
6. Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment that ensure that such water will not create a hazard or adversely affect other building areas or materials.
7. Protect floors and other surfaces along haul routes from damage, wear, and staining.
8. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.
9. Protect adjacent surfaces and equipment by covering them with heavy polyethylene film and waterproof masking tape[**or a liquid-strippable masking agent**]. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
10. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
11. Dispose of debris and runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Existing Drains: Prior to the start of concrete-maintenance work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin concrete-maintenance work in an area until the drainage system is in working order.

1. Prevent solids, such as aggregate or mortar residue, from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete-maintenance work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

D. Preparation for Concrete Removal: Examine construction to be repaired to determine best methods to safely and effectively perform concrete-maintenance work. Examine adjacent work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.

1. Verify that affected utilities have been disconnected and capped.
2. Inventory and record the condition of items to be removed for reinstallation or salvage.
3. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.

E. Reinforcing-Bar Preparation: Remove loose and flaking rust from exposed reinforcing bars by [**high-pressure water cleaning**][**abrasive blast cleaning**][**needle scaling**][**or**][**wire brushing**] until only

tightly adhered light rust remains.

1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, cut bars and remove and replace as indicated on Drawings.
2. Remove additional concrete as necessary to provide at least **3/4-inch (19-mm)** clearance at existing and replacement bars.
3. Splice replacement bars to existing bars in accordance with **ACI 318 (ACI 318M)** by lapping, welding, or using mechanical couplings.

F. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**] deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.

G. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete to remove dirt, oils, films, and other materials detrimental to treatment application.

1. Use [**low-pressure water cleaning**][**detergent scrubbing**][**or**][**sand blasting**].
2. Allow surface to dry before applying corrosion-inhibiting treatment.

H. Surface Preparation for Overlays:

1. Remove delaminated material and deteriorated concrete surface material.
2. Roughen surface of concrete to produce a surface profile matching CSP [**3**][**4**][**5**][**6**][**7**][**8**][**9**] in accordance with ICRI 310.2.
3. Use [**sand blasting**][**shot blasting**][**scarifying**][**needle scaling**][**high-pressure water jetting**][**scabbling**][**flame blasting**][**or**][**milling**].
4. Sweep and vacuum roughened surface to remove debris[**followed by low-pressure water cleaning**].

I. Acidic Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 in accordance with ICRI 310.2.[**Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.**]

1. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
2. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
3. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable in accordance with sealer manufacturer's written instructions.
4. When pH is acceptable in accordance with sealer manufacturer's written instructions and surface is clean, vacuum dry.

J. Nonacidic Surface Preparation for Sealers: Clean concrete to remove dirt, oils, films, and other materials detrimental to sealer application.

1. Use [**shot blasting**][**low-pressure water cleaning**][**or**][**detergent scrubbing**].

K. Surface Preparation for Composite Structural Reinforcement: Clean concrete where reinforcement and epoxy patching mortar is to be placed by [**low-pressure water cleaning**][**or**][**detergent scrubbing**] to remove dirt, oils, films, and other materials detrimental to epoxy patching mortar.

1. Roughen surface of concrete by sand blasting.
2. Remove delaminated material and deteriorated concrete surface material.
3. Sweep and vacuum roughened surface to remove debris[**followed by low-pressure water cleaning**].

3.4 REMOVAL OF CONCRETE

A. Do not overload structural elements with debris.

B. Saw-cut perimeter of areas indicated for removal to a depth of at least [1/2 inch (13 mm)]. Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.

C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.

D. Remove additional concrete if necessary to provide a depth of removal of at least [1/2 inch (13 mm)] over entire removal area.

E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least 3/4-inch (19-mm) clearance around bar.

F. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.

G. Provide surfaces with a fractured profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level unless otherwise directed.

H. Thoroughly clean removal areas of loose concrete, dust, and debris.

3.5 APPLICATION OF BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion System: Apply to reinforcing bars [**and concrete**]by stiff brush or hopper spray in accordance with manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.

B. Epoxy Bonding System: Apply to reinforcing bars[**and concrete**] by brush, roller, or spray in accordance with manufacturer's written instructions, leaving no pinholes or other uncoated areas.[**Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat.**] Place patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.

C. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.

D. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface in accordance with manufacturer's written instructions. Place patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.

E. Mortar Scrub Coat for Job-Mixed Patching Mortar and Concrete: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub coat dries, recoat before placing patching mortar or concrete.

F. Slurry Coat for Cementitious Patching Mortar: Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar[**mixed with latex bonding agent**] into substrate, filling pores and voids.

3.6 INSTALLATION OF PATCHING MORTAR

A. Place patching mortar as specified in this article unless otherwise recommended in writing by manufacturer[**or where dry-pack mortar is indicated**].

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified [**bonding agent**][**mortar scrub coat**][**slurry coat**][**bonding agent and slurry coat**].

C. General Placement: Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.

D. Vertical Patching: Place material in lifts of not more than [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**][**3 inches (76 mm)**] or less than [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]. Do not feather edge.

E. Overhead Patching: Place material in lifts of not more than [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (50 mm)**] or less than [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]. Do not feather edge.

F. Consolidation: After each lift is placed, consolidate material and screed surface.

G. Multiple Lifts: Where multiple lifts are used, score surface of lifts to provide a rough surface for placing subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.

H. Finishing: Allow surfaces of lifts that are to remain exposed to become firm and then finish to a [**smooth surface with a wood or sponge float**][**rough surface with a broom or burlap drag**][**surface matching adjacent concrete**].

I. Curing: Wet-cure cementitious patching materials, including polymer-modified cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.7 INSTALLATION OF DRY-PACK MORTAR

A. Use dry-pack mortar for deep cavities[**and where indicated**]. Place as specified in this article unless otherwise recommended in writing by manufacturer.

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified [**bonding agent**][**mortar scrub coat**][**slurry coat**][**bonding agent and slurry coat**].

C. Place dry-pack mortar into cavity by hand, and compact tightly into place. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.

D. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.

E. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.8 CONCRETE PLACEMENT

A. Place concrete in accordance with [**Section 033000 "Cast-in-Place Concrete"**][**Section 033300 "Architectural Concrete"**] and as specified in this article.

B. Epoxy-Modified Pretreatment: Apply [**epoxy-modified, cementitious bonding and anticorrosion agent**][**epoxy bonding agent**] to reinforcement[**and concrete substrate**].

C. Latex Pretreatment: Apply [**latex bonding agent**][**Type I latex bonding agent**][**mortar scrub coat**] to concrete substrate.

D. Standard Placement: Place concrete by form-and-pump method unless otherwise indicated.

1. Use vibrators to consolidate concrete as it is placed.
2. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.

E. Form-and-Pump Placement: Place concrete by form-and-pump method where indicated.

1. Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and where forms abut existing concrete.
2. Pump concrete into place from bottom to top, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to **14 psi (96 kPa)**.

F. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

G. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.

3.9 GROUTING PREPLACED AGGREGATE CONCRETE

A. Use grouted preplaced aggregate concrete [**where indicated**][**for column and wall repairs**]. Place as specified in this article.

B. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and where forms abut existing concrete.

C. Apply [**epoxy-modified cementitious bonding and anticorrosion agent**][**epoxy bonding agent**] to reinforcement[**and concrete substrate**].

D. Place aggregate in forms, consolidating aggregate in lifts as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.

E. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.

F. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to **14 psi (96 kPa)**.

G. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

H. Repair voids with patching mortar and finish to match surrounding concrete.

3.10 FLOOR-JOINT REPAIR

A. Cut out deteriorated concrete [**and reconstruct sides of joint with patching mortar**] as indicated on Drawings. Install joint filler in nonmoving floor joints where indicated and as specified in this article.

B. Depth: Install joint filler to a depth of at least [**3/4 inch (19 mm)**][**1 inch (25 mm)**][**2 inches (50 mm)**]. Use fine silica sand no more than **1/4 inch (6 mm)** deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.

C. Top Surface: Install joint filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.

3.11 APPLICATION OF EPOXY CRACK-INJECTION MATERIALS

A. Clean cracks with oil-free compressed air or low-pressure water to remove loose particles.

B. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond.

C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.

D. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least **1/4 inch (6 mm)** thick by **1 inch (25 mm)** wider than crack.

E. Inject cracks wider than **0.003 inch (0.075 mm)** to a depth of **8 inches (200 mm)**.

F. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.

G. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

3.12 APPLICATION OF CORROSION-INHIBITING MATERIALS

A. Apply corrosion-inhibiting treatment to [**surfaces indicated on Drawings, from wall to wall or curb to curb and from joint to joint in the perpendicular direction**].

B. Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete[**or applying a sealer or overlay**].

3.13 APPLICATION OF POLYMER-OVERLAY MATERIALS

A. Apply polymer overlay in accordance with ACI 503.3.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.14 APPLICATION OF POLYMER-SEALER MATERIALS

A. Apply polymer sealer by brush, roller, or airless spray at manufacturer's recommended application rate.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.15 INSTALLATION OF COMPOSITE REINFORCEMENT MATERIALS

A. Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, install as follows:

1. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
2. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
3. Apply epoxy saturant to [**fiber tow sheet**][**or**][**primed and patched surface**] using roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy to fully saturate tow sheet.
4. Apply additional layers using same procedure, fully saturating each layer with epoxy.
5. After saturant has cured, apply protective topcoat by [**brush**][**roller**][**or**][**spray**].

B. Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, install as follows:

1. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
2. Apply epoxy adhesive to a thickness of **1/16 inch (1.6 mm)** to prepared concrete surfaces.
3. Clean fiber sheet with acetone or other suitable solvent and apply epoxy adhesive to a thickness of **1/16 inch (1.6 mm)**.
4. Apply adhesive-coated fiber sheet to adhesive-coated concrete and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
5. Apply additional layers using same procedure.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Packaged, Cementitious Patching-Mortar Application: randomly selected sets of samples for each type of mortar required, tested in accordance with ASTM C928/C928M.
2. Job-Mixed Patching-Mortar Application: As directed by the Owner, randomly selected sets of samples for each type of mortar required, tested for compressive strength in accordance with ASTM C109/C109M.
3. Concrete: As specified in [**Section 033000 "Cast-in-Place Concrete."**][**Section 033300 "Architectural Concrete."**]
4. Grout for Preplaced Aggregate: Tested for compressive strength in accordance with ASTM C942/C942M.

    a. Testing Frequency: One sample for each **25 cu. yd. (19 cu. m)** of grout or fraction thereof,

but not less than one sample for each day's work.

5. Joint Filler: Core-drilled samples to verify proper installation.

   a. Testing Frequency: One sample for each **100 ft. (30 m)** of joint filled.
   b. Where samples are taken, refill holes with joint filler.

6. Epoxy Crack-Injection Materials: Core-drilled samples to verify proper installation.

   a. Testing Frequency: [**Three samples from mockup and**]one sample for each **100 ft. (30 m)** of crack injected.
   b. Where samples are taken, refill holes with epoxy mortar.

7. Product will be considered defective if it does not pass tests and inspections.

C. Manufacturers Field Service: Engage manufacturers' factory-authorized service representatives for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.

1. Have manufacturers' factory-authorized service representatives perform the following number of Project-site inspections to observe progress and quality of the Work, distributed over the period of product installation, regardless of on-site assistance requested by Architect:

   a. Bonding-Agent and Packaged Patching-Mortar Installation: [**Three**] inspections.
   b. Joint-Filler Installation: [**Two**] inspections.
   c. Crack-Injection-Adhesive Preparation and Installation: [**Four**] inspections.
   d. Corrosion-Inhibiting Treatment Installation: [**Two**] inspections.
   e. Polymer-Overlay Installation: [**Two**] inspections.
   f. Polymer Sealer: [**Two**] inspections.
   g. Composite-Structural Reinforcement: [**Three**] inspections.

D. Prepare test and inspection reports.

3.17 CONCRETE MAINTENANCE SCHEDULE

A. Garage Level 1 Entrance Ramp: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement on underside of slab.

B. Elevated Warehouse Floors: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement on underside of slab.

C. Concrete Walls and Floor in Salt Dome: Perform the following as indicated on Drawings:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor-joint repair.
3. Epoxy crack-injection materials.
4. Corrosion-inhibiting materials.
5. Polymer-overlay materials.
6. Polymer-sealer materials.
7. Composite reinforcement of columns.

END OF SECTION 09 01 90 52

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SECTION 09 01 90 52A - MAINTENANCE REPAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparatory cleaning materials.
2. Paint removers.
3. Paint materials.
4. Patching materials.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.
2. Section 040110 "Masonry Cleaning" for cleaning and removing paint from masonry.
3. Section 050170.51 "Decorative Metal Cleaning" for cleaning and removing paint from decorative metal.
4. [**Section 099113 "Exterior Painting," Section 099123 "Interior Painting," Section 099300 "Staining and Transparent Finishing," and Section 099600 "High-Performance Coatings"**][**Section 099114 "Exterior Painting (MPI Standards)," Section 099124 "Interior Painting (MPI Standards)," Section 099301 "Staining and Transparent Finishing (MPI Standards)," and Section 099601 "High-Performance Coatings (MPI Standards)"**] for Paint materials and systems for new construction.
5. Section 099423 "Gilding" for oil gilding.

1.2 ALLOWANCES

A. Allowances for maintenance repainting are specified in Section 012100 "Allowances."

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1. Unit prices apply to authorized work covered by [**quantity allowances**][**estimated quantities**] .
2. Unit prices apply to authorized additions to and deletions from Work as authorized by Change Orders.

1.4 DEFINITIONS

A. DSD: Degree of surface deterioration.

B. Gloss Level G1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, in accordance with ASTM D523.

C. Gloss Level G2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.

D. Gloss Level G3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.

E. Gloss Level G4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, in accordance with ASTM D523.

F. Gloss Level G5: 35 to 70 units at 60 degrees, in accordance with ASTM D523.

G. Gloss Level G6: 70 to 85 units at 60 degrees, in accordance with ASTM D523.

H. Gloss Level G7: More than 85 units at 60 degrees, in accordance with ASTM D523.

I. Low-Pressure Spray: [**100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**]<**Insert range of values**> .

J. Medium-Pressure Spray: [**400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)**]<**Insert range of values**> .

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**]<**Insert location**> .

1.6 SEQUENCING

A. Perform maintenance repainting in the following sequence, which includes Work specified in this and other Sections.

1. Dismantle existing surface-mounted objects and hardware except items indicated to remain in place. Tag items with location identification and protect from damage.
2. Verify that temporary protections have been installed.
3. Examine condition of surfaces to be painted.
4. Remove existing paint to the degree required for each substrate and surface condition of existing paint.
5. Apply paint system.
6. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

1.7 ACTION SUBMITTALS

A. Product Data: For each specified system and assembly, including components and accessories.

1. Include recommendations for product application and use.
2. Include test data substantiating that products comply with requirements.

B. Samples: For each type of paint system and each pattern, color, and gloss; [**in sizes indicated below**][**minimum 6 inches (150 mm) long in least dimension, but not less than whole pattern**] .

1. Include stepped Samples defining each separate coat, including fillers and primers. Resubmit until each required sheen, color, and texture is achieved.
2. For each painted color being matched to a standardized color-coding system, include the color chips from the color-coding-system company with Samples.

3. Include a list of materials for each coat of each Sample.
4. Label each Sample for location and application.
5. Sample Size:

    a. Painted Surfaces: [**4-by-8-inch (100-by-200-mm)**]<**Insert dimensions**> Samples for each color and material, on hardboard.
    b. Stained or Natural Wood: [**12-by-12-inch (300-by-300-mm)**]<**Insert dimensions**> Samples of natural- or stained-wood finish, on representative <**Insert required species of wood**> surfaces.

C. Product List: For each paint product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each MPI-product category specified in paint systems, with the proposed product highlighted.
3. VOC content.

D. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.

1.8 INFORMATIONAL SUBMITTALS

A. Color Matching Certificate: For computer-matched colors.

B. Preconstruction Test Reports: For cleaning materials, [**paint removers**][**and**][**paint coatings and systems**] .

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra paint materials, from the same production run, that match products applied and that are packaged with protective covering for storage and identified with labels describing contents, including material, finish, source, and location on building.

1. Quantity: Furnish Owner with an additional [**3**][**5**][**7**]<**Insert number**> percent, but not less than **1 gal. (3.8 L)** or one case, as appropriate, of each material and color applied.

1.10 QUALITY ASSURANCE

A. Color Matching: Custom computer-match paint colors [**as indicated in a color schedule on Drawings**]<**Insert requirements**> .

1.11 MOCKUPS

A. Prepare mockups of maintenance repainting processes for each type of coating system and substrate indicated and each color and finish required to demonstrate aesthetic effects and to set quality standards for materials and execution. Duplicate appearance of approved Sample submittals.

1. Locate mockups [**on existing surfaces where directed by Architect**][**in locations that enable viewing under same conditions as the completed Work**]<**Insert requirement**> .

2. Surface-Preparation Mockups: On existing surfaces using applicable specified methods of cleaning and other surface preparation, provide mockup sample of at least [**100 sq. ft. (9 sq. m)**]<**Insert dimension**> .
3. Coating Mockups: [**Two**]<**Insert number**> surfaces of at least [**100 sq. ft. (9 sq. m)**]<**Insert dimension**> to represent surfaces and conditions for application of each type of coating system under same conditions as the completed Work.
4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.12 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing of cleaning materials, [**paint removers**][**and**][**compatibility of paint coatings and systems**] for each [**indicated**] type of painted surface.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste daily.

1.14 FIELD CONDITIONS

A. Weather Limitations: Proceed with maintenance repainting only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

B. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

C. Do not apply paint in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer for surface preparation and during paint application and drying periods.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 PREPARATORY CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of **140 to 160 deg F (60 to 71 deg C)**.

C. Detergent Solution: Solution prepared by mixing **2 cups (0.5 L)** of tetrasodium pyrophosphate (TSPP), **1/2 cup (125 mL)** of laundry detergent that contains no ammonia, **5 quarts (5 L)** of 5 percent sodium hypochlorite bleach, and **15 quarts (15 L)** of warm water for every **5 gal. (20 L)** of solution required.

D. Mildewcide: Commercial proprietary mildewcide or a job-mixed solution prepared by mixing **1/3 cup (80 mL)** of household detergent that contains no ammonia, **1 quart (1 L)** of 5 percent sodium hypochlorite bleach, and **3 quarts (3 L)** of warm water.

E. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.

F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

2.3 PAINT REMOVERS

A. Paint Removers, General: Manufacturer's standard formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
d. [**Dumond Chemicals, Inc**]
e. [**EaCo Chem, Inc.**]
f. [**PROSOCO, Inc**]
g. [**Shore Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Building Restoration Products, Inc.**]
b. [**Cathedral Stone Products, Inc.**]
c. [**Diedrich Technologies, Inc.; a Hohmann & Barnard company**]
d. [**Dumond Chemicals, Inc**]
e. [**EaCo Chem, Inc.**]
f. [**PROSOCO, Inc**]
g. [**Shore Corporation**]
h. <**Insert manufacturer's name**>

B. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation; containing no methylene chloride.

C. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline paste or gel formulation; containing no methylene chloride.

D. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation.

E. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation; containing no methanol or methylene chloride.

F. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation; containing no methanol or methylene chloride.

2.4 PAINT MATERIALS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule on Drawings**]<**Insert requirements**> .

C. MPI Standards: Provide products complying with MPI standards indicated in applicable maintenance repainting schedule articles and listed in the "MPI Approved Products List."

D. Transition Coat: Paint manufacturer's recommended coating for use where a residual existing coating is incompatible with the paint system.

E. VOC Content: For field applications [**that are inside the weatherproofing system**] , verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Clear Wood Finishes, Varnishes: 275 g/L.
9. Clear Wood Finishes, Lacquers: 275 g/L.
10. Floor Coatings: 50 g/L.
11. Shellacs, Clear: 730 g/L.
12. Shellacs, Pigmented: 550 g/L.
13. Stains: 100 g/L.

F. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Material Emissions and Pollutant Control: Verify not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with one of the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. Verify VOC content does not exceed limits of authorities having jurisdiction and the following:

a. Flat Coatings: 50 g/L.
b. Nonflat Coatings: 100 g/L.
c. Nonflat - High-Gloss Coatings: 150 g/L.
d. Concrete/Masonry Sealers: 100 g/L.
e. Dry-Fog Coatings: 150 g/L.
f. Floor Coatings: 100 g/L.
g. Industrial Maintenance Coatings: 250 g/L.
h. Low-Solids Coatings: 120 g/L.
i. Mastic Texture Coatings: 100 g/L.
j. Metallic Pigmented Coatings: 500 g/L.
k. Pretreatment Wash Primers: 420 g/L.
l. Primers, Sealers, and Undercoaters: 100 g/L.
m. Reactive Penetrating Sealers: 350 g/L.
n. Recycled Coatings: 250 g/L.
o. Rust-Preventive Coatings: 250 g/L.

H. VOC Content: For field applications inside the building, verify wall paints comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Interior Flat Latex Wall Paint: 50 g/L.
2. Interior Nonflat Latex Wall Paint: 150 g/L.

I. VOC Emissions: For field applications inside the building, verify wall paints contain no more than half of the chronic REL of VOCs when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify the building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.5 PAINT MATERIALS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**Benjamin Moore & Co.**]
2. [**Coronado Paint; Benjamin Moore & Co.**]
3. [**Insl-X Products; Benjamin Moore & Co.**]
4. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
5. [**Rodda Paint Co.**]
6. [**Rust-Oleum Corporation**]
7. [**Sherwin-Williams Company (The)**]
8. [**The Pittsburgh Paints Company**]
9. [**Valspar; a brand of The Sherwin-Williams Company**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Benjamin Moore & Co.**]
2. [**Coronado Paint; Benjamin Moore & Co.**]
3. [**Insl-X Products; Benjamin Moore & Co.**]
4. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
5. [**Rodda Paint Co.**]
6. [**Rust-Oleum Corporation**]
7. [**Sherwin-Williams Company (The)**]
8. [**The Pittsburgh Paints Company**]
9. [**Valspar; a brand of The Sherwin-Williams Company**]
10. <**Insert manufacturer's name**>

2.6 PATCHING MATERIALS

A. Patching Compound, General: Formulation specifically manufactured for repairs in damaged substrate materials as specified within tooling time required for the detail of work and site conditions; designed for filling voids that have deteriorated from weathering and decay, capable of filling deep holes, and spreading to feather edge.

B. Metal-Patching Compound: Two-part, polyester-resin, metal-patching compound; knife-grade formulation.

C. Cementitious Patching Compound: Repair materials specifically formulated and manufactured for filling type of cementitious substrates and for sanding or tooling prior to repainting; as recommended in writing by compound manufacturer for exposure to weather and traffic.

D. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Abatron, Inc**]
    b. [**Advanced Repair Technology, Inc.**]
    c. [**ConServ Epoxy LLC**]
    d. [**Gougeon Brothers, Inc.**]
    e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
    f. [**Protective Coating Company**]
    g. [**System Three Resins, Inc.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Abatron, Inc**]
    b. [**Advanced Repair Technology, Inc.**]
    c. [**ConServ Epoxy LLC**]
    d. [**Gougeon Brothers, Inc.**]
    e. [**Polymeric Systems, Inc.; PPG Industries, Inc.**]
    f. [**Protective Coating Company**]

g. [**System Three Resins, Inc.**]
h. <**Insert manufacturer's name**>

E. Gypsum-Plaster Patching Compound: Finish coat plaster and bonding compound in accordance with ASTM C842.

PART 3 - EXECUTION

3.1 PROTECTION OF EXISTING SURFACES

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless the solutions will not damage adjacent surfaces. Use protective materials that are UV resistant and waterproof. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Do not apply chemical solutions during winds of sufficient force to spread them to unprotected surfaces.
3. Neutralize and collect alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 MAINTENANCE REPAINTING, GENERAL

A. Maintenance Repainting Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from building interior at [**5 ft. (1.5 m)**][**10 ft. (3 m)**]<**Insert distance**> away from painted surface and from building exterior at [**20 ft. (6 m)**][**50 ft. (15 m)**]<**Insert distance**> away from painted surface.

B. Execution of the Work: In repainting surfaces, disturb them as minimally as possible and as follows:

1. Remove failed coatings and corrosion and repaint.
2. Verify that substrate surface conditions are suitable for repainting.
3. Allow other trades to repair items in place before repainting.

C. Mechanical Abrasion: Where mechanical abrasion is needed for the Work, use gentle methods, such as scraping and lightly hand sanding, that will not abrade softer substrates, reducing clarity of detail.

D. Heat Processes: Do not use torches, heat guns, or heat plates.

3.3 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for maximum moisture content and other conditions affecting performance of painting work. Comply with paint manufacturer's written instructions for inspection.

B. Maximum Moisture Content of Substrates: Do not begin application of coatings unless moisture content

of exposed surface is below the maximum value recommended in writing by paint manufacturer and not greater than the following maximum values when measured with an electronic moisture meter appropriate to the substrate material:

1. Concrete: 12 percent.
2. Gypsum Board: 12 percent.
3. Gypsum Plaster: 12 percent.
4. Masonry (Clay and CMU): 12 percent.
5. Portland Cement Plaster (Stucco): 12 percent.
6. Wood: 15 percent.

C. Alkalinity: Do not begin application of coatings unless surface alkalinity is within range recommended in writing by paint manufacturer. Conduct alkali testing with litmus paper on exposed plaster, cementitious, and masonry surfaces.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

1. If existing surfaces cannot be prepared to an acceptable condition for proper finishing by using specified surface-preparation methods, notify Architect in writing.

E. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Application of coating indicates acceptance of surfaces and conditions.

3.4 APPLICATION OF PREPARATORY CLEANING MATERIALS

A. General: Use the gentlest, appropriate method necessary to clean surfaces in preparation for painting. Clean all surfaces, corners, contours, and interstices.

B. Detergent Cleaning: Wash surfaces by hand using clean rags, sponges, and bristle brushes. Scrub surface with detergent solution and bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet. Rinse with water applied by clean rags or sponges.

C. Solvent Cleaning: Use solvent cleaning to remove oil, grease, smoke, tar, and asphalt from painted or unpainted surfaces before other preparation work. Wipe surfaces with solvent using clean rags and sponges. If necessary, spot-solvent cleaning may be employed just prior to commencement of paint application, provided enough time is allowed for complete evaporation. Use clean solvent and clean rags for the final wash to ensure that all foreign materials have been removed. Do not use solvents, including primer thinner and turpentine, that leave residue.

D. Mildew Removal: Clean off existing mildew by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. Rinse with water applied by clean rags or sponges.

E. Chemical Rust Removal:

1. Remove loose rust scale with specified abrasives for ferrous-metal cleaning.
2. Apply rust remover with brushes or as recommended in writing by manufacturer.
3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.

5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

F. Mechanical Rust Removal:

1. Remove rust with specified abrasives for ferrous-metal cleaning. Clean to bright metal.
2. Wipe off residue with mineral spirits and either steel wool or soft rags.
3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.5 APPLICATION OF PAINT REMOVERS

A. General: Remove paint where indicated on Drawings. Where cleaning methods have been attempted and further removal of the paint is required because of incompatible or unsatisfactory surfaces for repainting, remove paint to extent required by conditions.

1. Application: Apply paint removers in accordance with paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than recommended in writing by manufacturer.

   a. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks.
   b. After work is complete, remove protection no longer required. Remove tape and adhesive marks.

2. Brushes: Use brushes that are resistant to chemicals being used.

   a. Metal Substrates: If using wire brushes on metal, use brushes of same metal composition as metal being treated.
   b. Wood Substrates: Do not use wire brushes.

3. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

   a. Equip units with pressure gauges.
   b. Unless otherwise indicated, hold spray nozzle at least **6 inches (150 mm)** from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
   c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with nozzle having a cone-shaped spray.
   d. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
   e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F (60 and 71 deg C)** at flow rates indicated.

B. Paint Removal with Hand Tools: Remove paint manually using hand-held scrapers, wire brushes, sandpaper, and metallic wool as appropriate for the substrate material.

C. Paint Removal with Alkaline Paste Paint Remover:

1. Remove loose and peeling paint using [**water,**] scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or

as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**] -pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

D. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

1. Remove loose and peeling paint using [**water,**] scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with brushes or as recommended in writing by manufacturer.
3. Apply cover in accordance with manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**] -pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
8. For spots of remaining paint, apply alkaline paste paint remover in accordance with "Paint Removal with Alkaline Paste Paint Remover" Paragraph.

E. Paint Removal with Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using [**water,**] scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paintbrush. Apply in one or two coats in accordance with manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**] -pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

F. Paint Removal with Covered, Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using [**water,**] scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush or as recommended in writing by manufacturer.
3. Apply cover in accordance with manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [**cold**][**hot**] water applied by [**low**][**medium**] -pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove remaining chemicals and paint residue.

3.6 SUBSTRATE REPAIR

A. General: Repair substrate surface defects that are inconsistent with the surface appearance of adjacent materials and finishes.

B. Metal Substrates:

1. Preparation: Treat repair locations by wire-brushing and solvent cleaning. Use [**chemical**][**or**][**mechanical**] rust removal method to clean off rust.
2. Defects in Metal Surfaces: Repair non-load-bearing defects in existing metal surfaces, including dents and gouges more than [**1/16 inch (6 mm)**][**1/8 inch (3 mm)**]<**Insert dimension**> deep or [**1/2 inch (13 mm)**][**1 inch (25 mm)**]<**Insert dimension**> across and all holes and cracks by filling with metal-patching compound and sanding smooth. Remove burrs and protruding fasteners.
3. Priming: Prime iron and steel surfaces immediately after repair to prevent flash rusting. Stripe paint corners, crevices, bolts, welds, and sharp edges. Apply two coats to surfaces that are inaccessible after completion of the Work.

C. Cementitious Material Substrates:

1. General: Repair defects including dents and chips more than [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**]<**Insert dimension**> in size and all holes and cracks by filling with cementitious patching compound and sanding smooth. Remove protruding fasteners.
2. New and Bare Portland Cement Plaster (Stucco): Neutralize surface of plaster with mild acid solution as recommended in writing by paint manufacturer. In lieu of acid neutralization, follow manufacturer's written instruction for primer or transition coat over alkaline plaster surfaces.
3. Existing Concrete, Cement Plaster, and Other Cementitious Substrates: Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. If surfaces are too alkaline to paint, correct this condition before painting.

D. Wood Substrates:

1. Repair wood defects including dents and gouges more than [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]<**Insert dimension**> in size and all holes and cracks by filling with wood-patching compound and sanding smooth. Reset or remove protruding fasteners.
2. Where existing paint is allowed to remain, sand irregular buildup of paint, runs, and sags to achieve a uniformly smooth surface.

E. Gypsum-Plaster and Gypsum-Board Substrates:

1. Repair defects including dents and chips more than [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**]<**Insert dimension**> in size and all holes and cracks by filling with gypsum-plaster patching compound and sanding smooth. Remove protruding fasteners.
2. Rout out surface cracks to remove loose, unsound material; fill with patching compound and sand smooth.

3.7 APPLICATION OF PAINT MATERIALS, GENERAL

A. Comply with manufacturers' written instructions for application methods unless otherwise indicated in this Section.

B. Prepare surfaces to be painted in accordance with the Surface-Preparation Schedule and with manufacturer's written instructions for each substrate condition.

C. Apply a transition coat over incompatible existing coatings.

D. Metal Substrates: Stripe paint corners, crevices, bolts, welds, and sharp edges before applying full coat. Apply two coats to surfaces that are inaccessible after completion of the Work. Tint stripe coat different than the main coating and apply with brush.

E. Blending Painted Surfaces: When painting new substrates patched into existing surfaces or touching up missing or damaged finishes, apply coating system specified for the specific substrate. Apply final finish coat over entire surface from edge to edge and corner to corner.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage paint-remover manufacturer's factory-authorized service representative for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.

B. Paint Material Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for composition and dry film thickness.

1. Paint Composition: The following procedure may be performed at any time and as often as Owner deems necessary during the period when paints are being applied:

   a. Testing agency will sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance of paint materials with product requirements.
   c. If test results show materials being used do not comply with product requirements, Contractor will remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

2. Dry Film Thickness:

   a. Contractor will touch up and restore painted surfaces damaged by testing.
   b. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor will pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.9 CLEANING

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.10 PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.11 SURFACE-PREPARATION SCHEDULE

A. General: Before painting, prepare surfaces [**where indicated on Drawings**] for painting in accordance with applicable requirements specified in this schedule.

1. Examine surfaces to evaluate each surface condition in accordance with paragraphs below.
2. Where existing degree of soiling prevents examination, preclean surface and allow it to dry before making an evaluation.
3. Repair substrate defects in accordance with "Substrate Repair" Article.

B. Surface Preparation for Sound Surfaces: [**MPI DSD 0**]<**Insert designation**> .

1. Surface Condition: Existing paint film in good condition and tightly adhered.
2. Paint Removal: Not required.
3. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Roughen or degloss cleaned surfaces to ensure paint adhesion in accordance with paint manufacturer's written instructions.

C. Surface Preparation for Slightly Deteriorated Surfaces: [**MPI DSD 1**]<**Insert designation**> .

1. Surface Condition: Paint film cracked or broken but adhered. Surface may include visual (aesthetic) defects that do not affect film's protective properties.
2. Paint Removal: Scrape by hand-tool cleaning methods to remove loose paint until only tightly adhered paint remains.
3. Preparation for Painting: Wash surface by detergent cleaning; use other cleaning methods for small areas of bare substrate if required. Roughen, degloss, and sand the cleaned surfaces to ensure paint adhesion and a smooth finish in accordance with paint manufacturer's written instructions.

D. Surface Preparation for Moderately Deteriorated Surfaces: [**MPI DSD 2**]<**Insert designation**> .

1. Surface Condition: Paint film loose, flaking, or peeling. Surface may show fading such as gloss reduction, slight surface contamination, minor pin holes, scratches, or minor cosmetic defects such as runs or sags.
2. Paint Removal: Remove loose, flaking, or peeling paint film by hand-tool or chemical paint-removal methods.
3. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Use other cleaning methods for small areas of bare substrate if required. Sand surfaces to smooth remaining paint film edges. Prepare bare cleaned surface to be painted in accordance with paint manufacturer's written instructions for substrate construction materials.

E. Surface Preparation for Severely Deteriorated Surfaces: [**MPI DSD 3**]<**Insert designation**> .

1. Surface Condition: Paint film [**severely deteriorated**][**obscuring fine architectural detail work because of paint-layer buildup**][**and**][**surface indicated to have paint completely removed**] .
2. Paint Removal: Completely remove paint film by hand-tool or chemical paint-removal methods. Remove rust.
3. Preparation for Painting: Prepare bare cleaned surface in accordance with paint manufacturer's written instructions for substrate construction materials.

F. Surface Preparation for Damaged Substrate Surfaces: [**MPI DSD 4**]<**Insert designation**> .

1. Surface Condition: Missing material, small holes and openings, and damaged or corroded substrate.
2. Substrate Preparation: Repair, replace, and treat substrate in accordance with "Substrate Repair" Article [**and requirements in other Specification Sections**] .
3. Preparation for Painting: Sand substrate surfaces to smooth remaining paint film edges and prepare in accordance with paint manufacturer's written instructions for substrate construction materials. Remove rust.
4. Painting: Paint as required for [**MPI DSD 2**]<**Insert designation**> degree of surface degradation.

3.12 EXTERIOR MAINTENANCE REPAINTING SCHEDULE

A. Ferrous Metal Substrates:

1. Alkyd System: [**MPI REX 5.1D**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, metal, surface tolerant [**, MPI #23**] .
        3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, metal, surface tolerant [**, MPI #23**] .
        4) <**Insert manufacturer's name; product name or designation**> .

    b. Intermediate Coat: Matching topcoat.
    c. Topcoat:

        1) Alkyd, exterior (Gloss Level G5) [**, MPI #94**] .
        2) Alkyd, exterior (Gloss Level G6) [**, MPI #9**] .
        3) <**Insert manufacturer's name; product name or designation**> .

2. High-Performance, Pigmented-Polyurethane-over-Epoxy System: [**MPI REX 5.1H**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, epoxy, anti-corrosive, for metal [**, MPI #101**] .
        3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, epoxy, anti-corrosive, for metal [**, MPI #101**] .
        4) <**Insert manufacturer's name; product name or designation**> .

    b. Intermediate Coat in Primed Areas: Epoxy, high build [**, MPI #108**] .
    c. Topcoat: Polyurethane, two-component, pigmented, Gloss Level G6 [**, MPI #72**] .

        1) <**Insert manufacturer's name; product name or designation**> .

    d. Second Topcoat: Match topcoat.

B. Dimension Lumber Substrates:

1. Applications: Columns, beams, soffits, siding, and fencing.
2. Latex System: [**MPI REX 6.2A**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, alkyd, for exterior wood [**, MPI #5**] .
        3) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, latex, for exterior wood [**, MPI #6**] .
        4) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [**, MPI #5**] .
        5) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, latex, for exterior wood [**, MPI #6**] .
        6) <**Insert manufacturer's name; product name or designation**> .

    b. Intermediate Coat: Matching topcoat.
    c. Topcoat:

        1) Latex, exterior, Gloss Levels G1-G2 [**, MPI #10**] .
        2) Latex, exterior, Gloss Levels G3-G4 [**, MPI #15**] .
        3) Latex, exterior, Gloss Level G5 [**, MPI #11**] .
        4) Latex, exterior, Gloss Level G6 [**, MPI #119**] .
        5) <**Insert manufacturer's name; product name or designation**> .

3. Alkyd System: [**MPI REX 6.2C**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, alkyd, for exterior wood [**, MPI #5**] .
        3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [**, MPI #5**] .
        4) <**Insert manufacturer's name; product name or designation**> .

    b. Intermediate Coat: Matching topcoat.
    c. Topcoat:

        1) Alkyd, exterior, Gloss Level G1 [**, MPI #8**] .
        2) Alkyd, exterior, Gloss Level G5 [**, MPI #94**] .
        3) Alkyd, exterior, Gloss Level G6 [**, MPI #9**] .
        4) <**Insert manufacturer's name; product name or designation**> .

C. Dressed Lumber Substrates:

1. Applications: Doors, windows, door and window frames, casings, and smooth fascia.
2. Latex System: [**MPI REX 6.3A**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime

with primer, alkyd, for exterior wood [**, MPI #5**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [**, MPI #5**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, exterior, Gloss Levels G1-G2 [**, MPI #10**] .
2) Latex, exterior, Gloss Levels G3-G4 [**, MPI #15**] .
3) Latex, exterior, Gloss Level G5 [**, MPI #11**] .
4) Latex, exterior, Gloss Level G6 [**, MPI #119**] .
5) <**Insert manufacturer's name; product name or designation**> .

3. Alkyd System: [**MPI REX 6.3B**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, alkyd, for exterior wood [**, MPI #5**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [**, MPI #5**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, exterior, Gloss Level G1 [**, MPI #8**] .
2) Alkyd, exterior, Gloss Level G5 [**, MPI #94**] .
3) Alkyd, exterior, Gloss Level G6 [**, MPI #9**] .
4) <**Insert manufacturer's name; product name or designation**> .

4. Varnish System (Clear): [**MPI REX 6.3F**]<**Insert system description**> .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with topcoat.
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Varnish, with UV inhibitor, exterior, Gloss Level G5 [**, MPI #30**] .
2) Varnish, with UV inhibitor, exterior, Gloss Level G6 [**, MPI #29**] .
3) Varnish, marine spar, exterior, Gloss Level G6 [**, MPI #28**] .
4) <**Insert manufacturer's name; product name or designation**> .

D. Wood Decks and Stairs Substrates:

1. Latex Porch and Floor System over Alkyd Primer: [**MPI REX 6.5A**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, alkyd, for exterior wood [**, MPI #5**] .
        3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [**, MPI #5**] .
        4) <**Insert manufacturer's name; product name or designation**> .

    b. Intermediate Coat: Matching topcoat.
    c. Topcoat:

        1) Floor paint, latex, low gloss [**, MPI #60**] .
        2) Floor paint, latex, gloss [**, MPI #68**] .
        3) <**Insert manufacturer's name; product name or designation**> .

    d. Topcoat Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

2. Alkyd Floor Enamel System: [**MPI REX 6.5B**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with topcoat.
        3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with topcoat.
        4) <**Insert manufacturer's name; product name or designation**> .

    b. Intermediate Coat: Matching topcoat.
    c. Topcoat:

        1) Floor enamel, alkyd, low gloss [**, MPI #59**] .
        2) Floor enamel, alkyd, gloss [**, MPI #27**] .
        3) <**Insert manufacturer's name; product name or designation**> .

    d. Topcoat Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

E. Wood Shingles and Shakes:

1. Latex System: [**MPI REX 6.6A**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, alkyd, for exterior wood [**, MPI #5**] .

3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [**, MPI #5**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, exterior, Gloss Levels G1-G2 [**, MPI #10**] .
2) Latex, exterior, Gloss Levels G3-G4 [**, MPI #15**] .
3) Latex, exterior, Gloss Level G5 [**, MPI #11**] .
4) Latex, exterior, Gloss Level G6 [**, MPI #119**] .
5) <**Insert manufacturer's name; product name or designation**> .

2. Alkyd System: [**MPI REX 6.6B**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, alkyd, for exterior wood [**, MPI #5**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, for exterior wood [**, MPI #5**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, exterior, Gloss Level G1 [**, MPI #8**] .
2) Alkyd, exterior, Gloss Level G5 [**, MPI #94**] .
3) Alkyd, exterior, Gloss Level G6 [**, MPI #9**] .
4) <**Insert manufacturer's name; product name or designation**> .

3.13 INTERIOR MAINTENANCE REPAINTING SCHEDULE

A. Ferrous Metal Substrates:

1. Latex System: [**MPI RIN 5.1N**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, metal, surface tolerant [**, MPI #23**] .
3) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, alkyd, anti-corrosive, for metal [**, MPI #79**] .
4) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, rust inhibitive, water based [**, MPI #107**] .
5) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, metal, surface tolerant [**, MPI #23**] .
6) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, anti-corrosive, for metal [**, MPI #79**] .
7) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime

coat with primer, rust inhibitive, water based [**, MPI #107**] .
8) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [**, MPI #53**] .
2) Latex, interior, Gloss Level G2 [**, MPI #44**] .
3) Latex, interior, Gloss Level G3 [**, MPI #52**] .
4) Latex, interior, Gloss Level G4 [**, MPI #43**] .
5) Latex, interior, Gloss Level G5 [**, MPI #54**] .
6) Latex, interior, Gloss Level G6 [**, MPI #114**] .
7) <**Insert manufacturer's name; product name or designation**> .

2. Alkyd System: [**MPI RIN 5.1E**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, metal, surface tolerant [**, MPI #23**] .
3) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, alkyd, anti-corrosive, for metal [**, MPI #79**] .
4) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, metal, surface tolerant [**, MPI #23**] .
5) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, alkyd, anti-corrosive, for metal [**, MPI #79**] .
6) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G1 [**, MPI #49**] .
2) Alkyd, interior, Gloss Level G3 [**, MPI #51**] .
3) Alkyd, interior, Gloss Level G5 [**, MPI #47**] .
4) Alkyd, interior, Gloss Level G6 [**, MPI #48**] .
5) <**Insert manufacturer's name; product name or designation**> .

3. High-Performance, Pigmented-Polyurethane-over-Epoxy System: [**MPI RIN 5.1H**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with epoxy, gloss [**, MPI #77**] .
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, zinc rich, organic [**, MPI #18**] .
3) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, zinc rich, epoxy [**, MPI #20**] .
4) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, zinc rich, organic [**, MPI #18**] .
5) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, zinc rich, epoxy [**, MPI #20**] .
6) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat in Primed Areas: Epoxy, gloss [**, MPI #77**] .
c. Topcoat: Polyurethane, two-component, pigmented, Gloss Level G6 [**, MPI #72**] .

1) <**Insert manufacturer's name; product name or designation**> .

d. Second Topcoat: Matching topcoat.

B. Dimension Lumber Substrates:

1. Applications: Columns, beams, exposed joists, and underside of decking.
2. Latex System over Latex Primer: [**MPI RIN 6.2D**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, latex, for interior wood [**, MPI #39**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, latex, for interior wood [**, MPI #39**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [**, MPI #53**] .
2) Latex, interior, Gloss Level G2 [**, MPI #44**] .
3) Latex, interior, Gloss Level G3 [**, MPI #52**] .
4) Latex, interior, Gloss Level G4 [**, MPI #43**] .
5) Latex, interior, Gloss Level G5 [**, MPI #54**] .
6) Latex, interior, Gloss Level G6 [**, MPI #114**] .
7) <**Insert manufacturer's name; product name or designation**> .

3. Latex System over Alkyd Primer: [**MPI RIN 6.2A**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with undercoat, enamel, interior [**, MPI #46**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with undercoat, enamel, interior [**, MPI #46**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [**, MPI #53**] .
2) Latex, interior, Gloss Level G2 [**, MPI #44**] .
3) Latex, interior, Gloss Level G3 [**, MPI #52**] .
4) Latex, interior, Gloss Level G4 [**, MPI #43**] .
5) Latex, interior, Gloss Level G5 [**, MPI #54**] .

6) Latex, interior, Gloss Level G6 [**, MPI #114**] .
7) <**Insert manufacturer's name; product name or designation**> .

4. Alkyd System: [**MPI RIN 6.2C**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with undercoat, enamel, interior [**, MPI #46**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with undercoat, enamel, interior [**, MPI #46**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G1 [**, MPI #49**] .
2) Alkyd, interior, Gloss Level G3 [**, MPI #51**] .
3) Alkyd, interior, Gloss Level G5 [**, MPI #47**] .
4) Alkyd, interior, Gloss Level G6 [**, MPI #48**] .
5) <**Insert manufacturer's name; product name or designation**> .

C. Wood Dressed Lumber Substrates:

1. Applications: Doors, windows, door and window frames, and moldings.
2. Latex System over Latex Primer: [**MPI RIN 6.3U**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, latex, for interior wood [**, MPI #39**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, latex, for interior wood [**, MPI #39**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G5 [**, MPI #54**] .
2) Latex, interior, Gloss Level G6 [**, MPI #114**] .
3) <**Insert manufacturer's name; product name or designation**> .

3. Low-Odor Latex System over Latex Primer: [**MPI RIN 6.3V**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, latex, for interior wood [**, MPI #39**] .

3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, latex, for interior wood [**, MPI #39**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, institutional low odor/VOC, Gloss Level G1 [**, MPI #143**] .
2) Latex, interior, institutional low odor/VOC, Gloss Level G2 [**, MPI #144**] .
3) Latex, interior, institutional low odor/VOC, Gloss Level G3 [**, MPI #145**] .
4) Latex, interior, institutional low odor/VOC, Gloss Level G4 [**, MPI #146**] .
5) Latex, interior, institutional low odor/VOC, Gloss Level G5 [**, MPI #147**] .
6) Latex, interior, institutional low odor/VOC, Gloss Level G6 [**, MPI #148**] .
7) <**Insert manufacturer's name; product name or designation**> .

4. Latex System over Alkyd Primer: [**MPI RIN 6.3A**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with undercoat, enamel, interior [**, MPI #46**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with undercoat, enamel, interior [**, MPI #46**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G5 [**, MPI #54**] .
2) Latex, interior, Gloss Level G6 [**, MPI #114**] .
3) <**Insert manufacturer's name; product name or designation**> .

5. Alkyd System: [**MPI RIN 6.3B**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with undercoat, enamel, interior [**, MPI #46**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with undercoat, enamel, interior [**, MPI #46**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G5 [**, MPI #47**] .
2) Alkyd, interior, Gloss Level G6 [**, MPI #48**] .
3) <**Insert manufacturer's name; product name or designation**> .

6. Alkyd Varnish System (Clear): [**MPI RIN 6.3J**]<**Insert system description**> .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with shellac [**, MPI #88**] .
3) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with alkyd, sanding sealer, clear [**, MPI #102**] .
4) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with shellac [**, MPI #88**] .
5) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with alkyd, sanding sealer, clear [**, MPI #102**] .
6) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Varnish, interior, Gloss Level G1 [**, MPI #73**] .
2) Varnish, interior, Gloss Level G5 [**, MPI #74**] .
3) Varnish, interior, Gloss Level G6 [**, MPI #75**] .
4) <**Insert manufacturer's name; product name or designation**> .

D. Wood Paneling, Casework, and Millwork:

1. Latex System over Latex Primer: [**MPI RIN 6.4T**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, latex, for interior wood [**, MPI #39**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, latex, for interior wood [**, MPI #39**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G5 [**, MPI #54**] .
2) Latex, interior, Gloss Level G6 [**, MPI #114**] .
3) <**Insert manufacturer's name; product name or designation**> .

2. Low-Odor Latex System over Latex Primer: [**MPI RIN 6.4D**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, latex, for interior wood [**, MPI #39**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, latex, for interior wood [**, MPI #39**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, institutional low odor/VOC, Gloss Level G1 [**, MPI #143**] .
2) Latex, interior, institutional low odor/VOC, Gloss Level G2 [**, MPI #144**] .
3) Latex, interior, institutional low odor/VOC, Gloss Level G3 [**, MPI #145**] .
4) Latex, interior, institutional low odor/VOC, Gloss Level G4 [**, MPI #146**] .
5) Latex, interior, institutional low odor/VOC, Gloss Level G5 [**, MPI #147**] .
6) Latex, interior, institutional low odor/VOC, Gloss Level G6 [**, MPI #148**] .
7) <**Insert manufacturer's name; product name or designation**> .

3. Latex System over Alkyd Primer: [**MPI RIN 6.4A**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with undercoat, enamel, interior [**, MPI #46**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with undercoat, enamel, interior [**, MPI #46**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [**, MPI #53**] .
2) Latex, interior, Gloss Level G2 [**, MPI #44**] .
3) Latex, interior, Gloss Level G3 [**, MPI #52**] .
4) Latex, interior, Gloss Level G4 [**, MPI #43**] .
5) Latex, interior, Gloss Level G5 [**, MPI #54**] .
6) Latex, interior, Gloss Level G6 [**, MPI #114**] .
7) <**Insert manufacturer's name; product name or designation**> .

4. Alkyd System: [**MPI RIN 6.4C**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with undercoat, enamel, interior [**, MPI #46**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with undercoat, enamel, interior [**, MPI #46**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G1 [**, MPI #49**] .
2) Alkyd, interior, Gloss Level G3 [**, MPI #51**] .
3) Alkyd, interior, Gloss Level G5 [**, MPI #47**] .
4) Alkyd, interior, Gloss Level G6 [**, MPI #48**] .
5) <**Insert manufacturer's name; product name or designation**> .

5. Alkyd Varnish System over Stain: [**MPI RIN 6.4F**]<**Insert system description**> .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with stain, semi-transparent, for interior wood [**, MPI #90**] .
        3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with stain, semi-transparent, for interior wood [**, MPI #90**] .
        4) <**Insert manufacturer's name; product name or designation**> .

    b. Intermediate Coat: Matching topcoat.
    c. Topcoat:

        1) Varnish, interior, Gloss Level G1 [**, MPI #73**] .
        2) Varnish, interior, Gloss Level G5 [**, MPI #74**] .
        3) Varnish, interior, Gloss Level G6 [**, MPI #75**] .
        4) <**Insert manufacturer's name; product name or designation**> .

    d. Stain Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule on Drawings**]<**Insert requirements**> .

E. Wood Floors and Stairs Substrates:

1. Latex Porch and Floor System over Alkyd Primer: [**MPI RIN 6.5J**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
        2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer sealer, alkyd, interior [**, MPI #45**] .
        3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer sealer, alkyd, interior [**, MPI #45**] .
        4) <**Insert manufacturer's name; product name or designation**> .

    b. Intermediate Coat: Matching topcoat.
    c. Topcoat:

        1) Floor paint, latex, low gloss [**, MPI #60**] .
        2) Floor paint, latex, gloss [**, MPI #68**] .
        3) <**Insert manufacturer's name; product name or designation**> .

    d. Topcoat Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

2. Alkyd Floor Enamel System: [**MPI RIN 6.5A**]<**Insert system description**> system [**over a transition coat**] .

    a. Prime Coat:

        1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.

2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with topcoat.
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Floor paint, alkyd, low gloss [**, MPI #59**] .
2) Floor enamel, alkyd, gloss [**, MPI #27**] .
3) <**Insert manufacturer's name; product name or designation**> .

d. Topcoat Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

3. Polyurethane Varnish System (Clear): [**MPI RIN 6.5C**]<**Insert system description**> .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with topcoat.
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, gloss [**, MPI #56**] .

1) <**Insert manufacturer's name; product name or designation**> .

4. Two-Component Aliphatic Polyurethane System (Clear): [**MPI RIN 6.5G**]<**Insert system description**> .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with topcoat.
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with topcoat.
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two-component [**, MPI #78**] .

1) <**Insert manufacturer's name; product name or designation**> .

5. Moisture-Cured Polyurethane System (over Stain): [**MPI RIN 6.5L**]<**Insert system description**> .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with stain, semi-transparent, for interior wood [**, MPI #90**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with stain, semi-transparent, for interior wood [**, MPI #90**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat: Varnish, polyurethane, moisture cured, Gloss Level G6 [**, MPI #31**] .

1) <**Insert manufacturer's name; product name or designation**> .

d. Stain Color: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule on Drawings**]<**Insert requirements**> .

F. Plaster Substrates:

1. Latex System over Waterborne Primer: [**MPI RIN 9.2A**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer sealer, latex, interior [**, MPI #50**] .
3) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, stain blocking, water based [**, MPI #137**] .
4) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer sealer, latex, interior [**, MPI #50**] .
5) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, stain blocking, water based [**, MPI #137**] .
6) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [**, MPI #53**] .
2) Latex, interior, Gloss Level G2 [**, MPI #44**] .
3) Latex, interior, Gloss Level G3 [**, MPI #52**] .
4) Latex, interior, Gloss Level G4 [**, MPI #43**] .
5) Latex, interior, Gloss Level G5 [**, MPI #54**] .
6) Latex, interior, Gloss Level G6 [**, MPI #114**] .
7) <**Insert manufacturer's name; product name or designation**> .

2. Low-Odor Latex System over Waterborne Primer: [**MPI RIN 9.2M**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer sealer, latex, interior [**, MPI #50**] .

3) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, stain blocking, water based [**, MPI #137**] .
4) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer sealer, latex, interior [**, MPI #50**] .
5) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, stain blocking, water based [**, MPI #137**] .
6) <**Insert manufacturer's name; product name or designation**> .

b. Topcoat:

1) Latex, interior, institutional low odor/VOC, Gloss Level G1 [**, MPI #143**] .
2) Latex, interior, institutional low odor/VOC, Gloss Level G2 [**, MPI #144**] .
3) Latex, interior, institutional low odor/VOC, Gloss Level G3 [**, MPI #145**] .
4) Latex, interior, institutional low odor/VOC, Gloss Level G4 [**, MPI #146**] .
5) Latex, interior, institutional low odor/VOC, Gloss Level G5 [**, MPI #147**] .
6) Latex, interior, institutional low odor/VOC, Gloss Level G6 [**, MPI #148**] .
7) <**Insert manufacturer's name; product name or designation**> .

3. Latex System over Alkyd Primer: [**MPI RIN 9.2K**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer sealer, alkyd, interior [**, MPI #45**] .
3) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat primer sealer, alkyd, interior [**, MPI #45**] .
4) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Latex, interior, Gloss Level G1 [**, MPI #53**] .
2) Latex, interior, Gloss Level G2 [**, MPI #44**] .
3) Latex, interior, Gloss Level G3 [**, MPI #52**] .
4) Latex, interior, Gloss Level G4 [**, MPI #43**] .
5) Latex, interior, Gloss Level G5 [**, MPI #54**] .
6) <**Insert manufacturer's name; product name or designation**> .

4. Alkyd System: [**MPI RIN 9.2C**]<**Insert system description**> system [**over a transition coat**] .

a. Prime Coat:

1) For [**MPI DSD 1**]<**Insert designation**> degree of surface degradation, touch up with topcoat.
2) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer sealer, latex, interior [**, MPI #50**] .
3) For [**MPI DSD 2**]<**Insert designation**> degree of surface degradation, spot prime with primer, stain blocking, water based [**, MPI #137**] .
4) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer sealer, latex, interior [**, MPI #50**] .
5) For [**MPI DSD 3**]<**Insert designation**> degree of surface degradation, fully prime coat with primer, stain blocking, water based [**, MPI #137**] .

6) <**Insert manufacturer's name; product name or designation**> .

b. Intermediate Coat: Matching topcoat.
c. Topcoat:

1) Alkyd, interior, Gloss Level G1 [**, MPI #49**] .
2) Alkyd, interior, Gloss Level G3 [**, MPI #51**] .
3) Alkyd, interior, Gloss Level G5 [**, MPI #47**] .
4) Alkyd, interior, Gloss Level G6 [**, MPI #48**] .
5) <**Insert manufacturer's name; product name or designation**> .

END OF SECTION 09 01 90 52A

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SECTION 09 05 61 13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. MVE-control system - fluid applied.
2. MVE-control system - sheet membranes.

1.2 ALLOWANCES

A. Concrete MVE-control systems are part of [**Moisture Vapor Emission Control Allowance**]<**Insert allowance**>.

1.3 UNIT PRICES

A. Work of this Section is affected by [**Moisture Vapor Emission Control Unit Price**]<**Insert unit price**>.

1.4 DEFINITIONS

A. MVE: Moisture vapor emission per ASTM F710, a term used by the flooring industry in the United States to measure moisture emission from concrete floors in pounds per 1000 sq. ft. during a 24-hour period (56.51 µg/(s m2) using the anhydrous calcium chloride test.

B. MVER: Moisture vapor emission rate per ASTM F1869, a term used to indicate the amount of water vapor in pounds emitted from a 1000 sq. ft. area of concrete flooring during a 24-hour period.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For waterproofing, providing information for testing in compliance with ASHRAE 160-2016.2009.
2. Product Data: For waterproofing, providing information for testing in compliance with CCR, Title 24, Part 2, Section 1202 and Ch. 14.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each MVE-control system, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

B. Preinstallation testing reports.

C. Field quality control reports.

D. Qualification Statements: For [**Installer**][**manufacturer**].

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.

B. Installer Qualifications: [**Fabricator of products**][**Entity that employs installers and supervisors who are trained and approved by manufacturer**][**Authorized representative who is trained and approved by manufacturer**].

1.9 MOCKUPS

A. Build mockups [**to verify selections made under Sample submittals**][**to demonstrate aesthetic effects**][**to set quality standards for materials and execution**][**to set quality standards for fabrication and installation**][**and**][**for preconstruction testing**].

1. Build mockup [**as indicated on Drawings**][**as directed by Architect**]<**Insert mockup requirements**>.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.11 FIELD CONDITIONS

A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.

1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than **65 deg F (18 deg C)** and not more than **85 deg F (29.4 deg C)** at least 48 hours before use.
2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than **65 deg F (18 deg C)** or more than **85 deg F (29.4 deg C)** and not less than 40 or more than 60 percent relative

humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

3. Install MVE-control systems where concrete surface temperatures will remain a minimum of **5 deg F (3 deg C)** higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

1.12 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace the floor covering materials or floor coatings and the applied moisture vapor emission control system, that fails in materials and or workmanship within specified warranty period.

1. Warranty Period: [**5**][**10**][**20**]<**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:

1. MVER: Maximum [**15 lb of water/1000 sq. ft. (6.80 kg of water/92.9 sq. m)**][**25 lb of water/1000 sq. ft. (11.34 kg of water/92.9 sq. m)**][**30 lb of water/1000 sq. ft. (13.61 kg of water/92.9 sq. m)**]<**Insert rate**> when tested in accordance with ASTM F1869.
2. Relative Humidity: Maximum [**100**][**90**]<**Insert number**> percent when tested in accordance with ASTM F2170 using in situ probes.

B. Water-Vapor Transmission: Through MVE-control system, maximum [**0.10 perm (5.75 ng/Pa x s x sq. m)**][**0.02 perm (1.15 ng/Pa x s x sq. m)**][**0.05 perm (2.86 ng/Pa x s x sq. m)**][**0.06 perm (3.45 ng/Pa x s x sq. m)**] when tested in accordance with ASTM E96/E96M.

C. Tensile Bond Strength: For MVE-control system, greater than [**200 psi (1.38 MPa)**]<**Insert pressure**> with failure in the concrete in accordance with ASTM D7234.

2.2 MVE-CONTROL SYSTEM - FLUID APPLIED

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Advanced Moisture Control, Inc.**]
2. [**ARDEX Americas**]
3. [**Custom Building Products**]
4. [**Dependable, LLC**]
5. [**Floor Seal Technology, Inc.**]
6. [**H.B. Fuller Construction Products Inc. / TEC**]
7. [**KOSTER American Corporation**]
8. [**Laticrete International, Inc.**]
9. [**MAPEI Corporation**]

10. [**Maxxon Corporation**]
11. [**Schonox HPS North America, Inc.**]
12. [**Synthetics International**]
13. [**USG Corporation**]
14. [**Uzin Utz North America, Inc.**]
15. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Advanced Moisture Control, Inc.**]
2. [**ARDEX Americas**]
3. [**Custom Building Products**]
4. [**Dependable, LLC**]
5. [**Floor Seal Technology, Inc.**]
6. [**H.B. Fuller Construction Products Inc. / TEC**]
7. [**KOSTER American Corporation**]
8. [**Laticrete International, Inc.**]
9. [**MAPEI Corporation**]
10. [**Maxxon Corporation**]
11. [**Schonox HPS North America, Inc.**]
12. [**Synthetics International**]
13. [**USG Corporation**]
14. [**Uzin Utz North America, Inc.**]
15. <**Insert manufacturer's name**>

C. MVE-Control System:

1. ASTM F3513 compliant-qualified, fluid-applied, single-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
2. ASTM F3010 compliant-qualified, fluid-applied, two-component, epoxy-resin, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
3. Water-based epoxy, fluid-applied, [**single**][**two**]-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
4. Polyurethane resin, fluid-applied, [**single**][**two**]-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
5. Acrylic-based, fluid-applied, [**two**][**three**]-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
6. Silicate-based, fluid-applied, single-component, membrane-forming system; formulated for application on [**new**][**and**][**existing**] concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
7. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

8. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
9. Verify adhesive complies with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify building concentration of formaldehyde does not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde does not exceed 9 mcg/cu. m.

2.3 MVE-CONTROL SYSTEM - SHEET MEMBRANES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. <**Insert manufacturer's name**>.

B. MVE-Control System: Sheet membrane, mold and fungal resistance per ASTM D3273, loose laid applied system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.

2.4 ACCESSORIES

A. Patching and Repair Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of [**3000 psi (20.68 MPa)**]<**Insert pressure**> compressive strength after 28 days when tested in accordance with ASTM C109/C109M.

B. Leveling Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of [**3000 psi (20.68 MPa)**]<**Insert pressure**> compressive strength after 28 days when tested in accordance with ASTM C109/C109M.

C. Crack and Joint Repair Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.

D. Substrate Primer: Provide MVE-control system manufacturer's substrate primer if required for system indicated by substrate conditions. Ensure adhesion of products to MVE-control system.

E. Cementitious Underlayment: [**Gypsum**][**Hydraulic**] cement-based underlayment. Provide product as recommended by MVE-control system manufacturer.

F. Seam Tapes: Double-sided tape to adhere to concrete surface and MVE-control sheet membrane surface with seal tape for seams.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the

Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of system indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Preinstallation Testing:

1. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests.
2. Alkalinity Testing: Perform pH testing in accordance with flooring manufacturer's written instructions or, in the absence thereof, in accordance with ASTM F3441. Install MVE-control system in areas where pH readings are outside the acceptable range of the flooring materials to be installed.
3. Moisture Testing: Perform tests so that each test area does not exceed [**200 sq. ft. (18.6 sq. m)**][**1000 sq. ft. (304.8 sq. m)**]<**Insert dimension**>, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Install MVE-control system in locations where concrete substrate MVER exceeds flooring manufacturer's published limits.
    b. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity levels that exceed flooring manufacturer's published limits.

4. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum [**100-sq. ft. (9.29-sq. m)**]<**Insert dimension**> area of MVE-control system to prepared concrete substrate and test in accordance with ASTM D7234.

    a. Proceed with installation only where tensile bond strength is greater than [**200 psi (1.38 MPa)**]<**Insert pressure**> with failure in the concrete.

B. Concrete Substrates: Prepare and clean substrates in accordance with MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.

1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
2. Provide concrete surface profile CSP as described within ICRI 310.2R as required by the MVE control system, if any, by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
3. After shot blasting, repair damaged and deteriorated concrete in accordance with MVE-control system manufacturer's written instructions.
4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
5. Fill surface depressions and irregularities with patching and repair material.
6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.

C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.3 INSTALLATION OF MVE-CONTROL SYSTEM - FLUID APPLIED

A. Confirm that Architect approved mockups.

B. Install MVE-control system - fluid applied in accordance with ASTM F3010 or ASTM F3513 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fisheyes, and voids.

1. Install primers as required to comply with manufacturer's written instructions.

C. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.

D. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.

E. Cure MVE-control system components in accordance with manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.

F. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies in accordance with manufacturer's written instructions.

G. Install cementitious underlayment over cured membrane if required to maintain manufacturer's warranty and in thickness required to maintain the warranty.

3.4 INSTALLATION OF MVE-CONTROL SYSTEM - SHEET MEMBRANES

A. Install MVE-control system - sheet membrane in accordance with manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fisheyes, and voids.

1. Install seam tapes required to comply with manufacturer's written instructions.
2. Per floor covering manufacturer's written instructions, finished floor covering requires at least 48 hours of acclimation in order to minimize expansion and contraction after installation. Do not install floor covering until proper acclimation occurs.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform installation inspections.

B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.

1. Verify that surface preparation meets requirements.
2. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired in accordance with manufacturer's written instructions.

C. MVE-control system will be considered defective if it does not pass inspections.

3.6 PROTECTION

A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.

B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION 09 05 61 13

Task	Specification	Specification Description
09 05 71 00	09 01 30 91	Ceramic Tiling
09 22 13 13	09 23 00 00	Gypsum Plastering
09 22 13 23	09 23 00 00	Gypsum Plastering

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SECTION 09 22 16 00 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonstructural steel framing.
2. Grid suspension systems.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing, structural framing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**]<**Insert location**> .

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of nonstructural steel framing and fastening and anchorage details.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, and attachments to adjoining work.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For code-compliance certification of studs and track.

B. Evaluation Reports: From [**an agency acceptable to authorities having jurisdiction**][**ICC-ES**]<**Insert evaluation agency**> showing compliance with Project requirements, for the following:

1. Studs and track.
2. High-strength steel studs and track.
3. Equivalent corrosion-resistant coating on steel framing.

4. Firestop track.
5. Post-installed anchors.
6. Power-actuated anchors.

1.5 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Track: Provide documentation that framing members are certified in accordance with product-certification program of [**the Steel Framing Industry Association**][**the Steel Stud Manufacturers Association**][**or**][**the Supreme Steel Framing System Association**] .

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Protect materials from corrosion, deformation, and other damage during delivery, storage, and handling in accordance with AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Where indicated on Drawings, provide assemblies incorporating nonstructural steel framing identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: Where indicated on Drawings, provide assemblies incorporating nonstructural steel framing identical to those of assemblies tested in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

C. Horizontal Deflection: For [**composite**][**non-composite**] wall assemblies, limited to [**1/240**][**1/360**]<**Insert requirements**> of the wall height based on the following horizontal loading:

1. Horizontal Loading: [**As indicated on Drawings**][**5 lbf/sq. ft. (240 Pa)**][**10 lbf/sq. ft. (480 Pa)**]<**Insert value**> .

2.2 NONSTRUCTURAL STEEL FRAMING

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with requirements in AISI S220 for conditions indicated on Drawings.

1. Protective Coating: ASTM A653/A653M, [**G40 (Z120)**][**G60 (Z180)**] hot-dip galvanized or coating with demonstrated equivalent corrosion resistance. Galvannealed products are unacceptable.

a. Equivalent Corrosion-Resistant Coating: Evaluation report acceptable to authorities having

jurisdiction demonstrates corrosion resistance equivalent to specified protective coating.

C. Studs and Track: Conventional members, roll-formed into standard shapes without surface deformations to stiffen framing members.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**CEMCO; California Expanded Metal Products Co.**]
   b. [**ClarkDietrich**]
   c. [**CRACO Mfg., Inc.**]
   d. [**Jaimes Industries, Inc.**]
   e. [**Marino\WARE**]
   f. [**MBA Building Supplies**]
   g. [**MBA Metal Framing**]
   h. [**MRI Steel Framing, LLC**]
   i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
   j. [**Steel Construction Systems; Stone Group of Companies**]
   k. [**Steel Network, Inc. (The)**]
   l. [**TELLING Industries**]
   m. [**UMS Metal Building Systems USA LLC**]
   n. [**US Frame Factory**]
   o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**CEMCO; California Expanded Metal Products Co.**]
   b. [**ClarkDietrich**]
   c. [**CRACO Mfg., Inc.**]
   d. [**Jaimes Industries, Inc.**]
   e. [**Marino\WARE**]
   f. [**MBA Building Supplies**]
   g. [**MBA Metal Framing**]
   h. [**MRI Steel Framing, LLC**]
   i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
   j. [**Steel Construction Systems; Stone Group of Companies**]
   k. [**Steel Network, Inc. (The)**]
   l. [**TELLING Industries**]
   m. [**UMS Metal Building Systems USA LLC**]
   n. [**US Frame Factory**]
   o. <**Insert manufacturer's name**>

3. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**As required by performance requirements for horizontal deflection**][**0.0179 inch (0.455 mm)**][**0.0296 inch (0.752 mm)**] .
4. Minimum Yield Strength: **33 ksi (230 MPa)**.
5. Depth: [**As indicated on Drawings**][**1-5/8 inches (41 mm)**][**2-1/2 inches (64 mm)**][**3-5/8 inches (92 mm)**][**4 inches (102 mm)**][**6 inches (152 mm)**]<**Insert dimension**> .

D. High-Strength Steel Studs and Track: Roll-formed into proprietary shapes incorporating ribs, embossment, knurling, or dimensional changes to stiffen framing members.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [CEMCO; California Expanded Metal Products Co.]
b. [ClarkDietrich]
c. [CRACO Mfg., Inc.]
d. [Marino\WARE]
e. [MBA Building Supplies]
f. [MBA Metal Framing]
g. [MRI Steel Framing, LLC]
h. [SCAFCO Steel Stud Company; Stone Group of Companies]
i. [Steel Construction Systems; Stone Group of Companies]
j. [TELLING Industries]
k. [The Mill Steel Co]
l. [US Frame Factory]
m. <Insert manufacturer's name>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

a. [CEMCO; California Expanded Metal Products Co.]
b. [ClarkDietrich]
c. [CRACO Mfg., Inc.]
d. [Marino\WARE]
e. [MBA Building Supplies]
f. [MBA Metal Framing]
g. [MRI Steel Framing, LLC]
h. [SCAFCO Steel Stud Company; Stone Group of Companies]
i. [Steel Construction Systems; Stone Group of Companies]
j. [TELLING Industries]
k. [The Mill Steel Co]
l. [US Frame Factory]
m. <Insert manufacturer's name>

3. Minimum Base-Steel Thickness and Yield Strength: [As indicated on Drawings][As required by horizontal deflection performance requirements][As required to provide equivalent capacity to conventional stud and track members specified and indicated on Drawings][0.0147 inch (0.373 mm) and 50 ksi (345 MPa)][0.0179 inch (0.455 mm) and 57 ksi (390 MPa)]<Insert requirements> .
4. Depth: [As indicated on Drawings][1-5/8 inches (41 mm)][2-1/2 inches (64 mm)][3-5/8 inches (92 mm)][4 inches (102 mm)][6 inches (152 mm)]<Insert dimension> .

E. Moisture-Barrier Bottom Track: Proprietary roll-formed steel shapes with ledges that lift finish panels 2 inches (51 mm) above the floor surface to prevent moisture damage.

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [TELLING Industries]
b. <Insert manufacturer's name>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**TELLING Industries**]
   b. <**Insert manufacturer's name**>

3. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**Matching studs**][**0.0179 inch (0.455 mm)**][**0.0296 inch (0.752 mm)**]<**Insert requirements**> .
4. Minimum Yield Strength: **33 ksi (230 MPa)**.
5. Depth: [**As indicated on Drawings**][**As required to accommodate studs**]<**Insert dimension**> .
6. Configuration: [**As indicated on Drawings**]<**Insert requirements**> .
7. Fire-Resistance-Rated Assemblies: Comply with requirements of assembly indicated on Drawings.

F. Slip-Type Head Joints: Where indicated on Drawings.

1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to track.

   a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

      1) [**CEMCO; California Expanded Metal Products Co.**]
      2) [**ClarkDietrich**]
      3) [**CRACO Mfg., Inc.**]
      4) [**Marino\WARE**]
      5) [**MBA Metal Framing**]
      6) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
      7) [**Steel Construction Systems; Stone Group of Companies**]
      8) [**Steel Network, Inc. (The)**]
      9) [**Super Stud Building Products Inc.**]
      10) [**US Frame Factory**]
      11) <**Insert manufacturer's name**>

   b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

      1) [**CEMCO; California Expanded Metal Products Co.**]
      2) [**ClarkDietrich**]
      3) [**CRACO Mfg., Inc.**]
      4) [**Marino\WARE**]
      5) [**MBA Metal Framing**]
      6) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
      7) [**Steel Construction Systems; Stone Group of Companies**]
      8) [**Steel Network, Inc. (The)**]
      9) [**Super Stud Building Products Inc.**]
      10) [**US Frame Factory**]
      11) <**Insert manufacturer's name**>

   c. Minimum Allowable Vertical Movement: [**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**2-1/2 inches (64 mm)**][**3 inches (76 mm)**]<**Insert dimension**> .

2. Single Long-Leg Track: Top track with solid, deep flanges in base-steel thickness not less than that of studs, installed with studs friction fit into track and with continuous bridging located within **12 inches (305 mm)** of the top of studs to provide lateral bracing.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**CEMCO; California Expanded Metal Products Co.**]
        2) [**ClarkDietrich**]
        3) [**Jaimes Industries, Inc.**]
        4) [**Marino\WARE**]
        5) [**MBA Building Supplies**]
        6) [**MRI Steel Framing, LLC**]
        7) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
        8) [**Steel Construction Systems; Stone Group of Companies**]
        9) [**Steel Network, Inc. (The)**]
        10) [**TELLING Industries**]
        11) [**The Mill Steel Co**]
        12) [**US Frame Factory**]
        13) <**Insert manufacturer's name**>

    b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

        1) [**CEMCO; California Expanded Metal Products Co.**]
        2) [**ClarkDietrich**]
        3) [**Jaimes Industries, Inc.**]
        4) [**Marino\WARE**]
        5) [**MBA Building Supplies**]
        6) [**MRI Steel Framing, LLC**]
        7) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
        8) [**Steel Construction Systems; Stone Group of Companies**]
        9) [**Steel Network, Inc. (The)**]
        10) [**TELLING Industries**]
        11) [**The Mill Steel Co**]
        12) [**US Frame Factory**]
        13) <**Insert manufacturer's name**>

    c. Flange Length: [**2 inches (51 mm)**][**2-1/2 inches (64 mm)**]<**Insert dimension**> .

3. Slotted Deflection Track: Steel sheet top track manufactured with deep flanges that allow positive attachment to studs through long slots and prevent deflection of structure above from cracking finishes applied to framing; in base-steel thickness not less than that of studs and in width to accommodate depth of studs.

    a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

        1) [**CEMCO; California Expanded Metal Products Co.**]
        2) [**ClarkDietrich**]

3) [**Jaimes Industries, Inc.**]
4) [**Marino\WARE**]
5) [**MBA Building Supplies**]
6) [**MRI Steel Framing, LLC**]
7) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
8) [**Steel Construction Systems; Stone Group of Companies**]
9) [**Steel Network, Inc. (The)**]
10) [**TELLING Industries**]
11) [**The Mill Steel Co**]
12) [**US Frame Factory**]
13) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**CEMCO; California Expanded Metal Products Co.**]
2) [**ClarkDietrich**]
3) [**Jaimes Industries, Inc.**]
4) [**Marino\WARE**]
5) [**MBA Building Supplies**]
6) [**MRI Steel Framing, LLC**]
7) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
8) [**Steel Construction Systems; Stone Group of Companies**]
9) [**Steel Network, Inc. (The)**]
10) [**TELLING Industries**]
11) [**The Mill Steel Co**]
12) [**US Frame Factory**]
13) <**Insert manufacturer's name**>

c. Flange Length: [**2-1/2 inches (64 mm)**]<**Insert dimension**> .

4. Double-Track System: Top outer track sized to friction-fit over inner track and inner track with deep flanges in base-steel thickness not less than that of studs and fastened to studs.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1) [**ClarkDietrich**]
2) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
3) [**Steel Construction Systems; Stone Group of Companies**]
4) [**US Frame Factory**]
5) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**ClarkDietrich**]
2) [**SCAFCO Steel Stud Company; Stone Group of Companies**]
3) [**Steel Construction Systems; Stone Group of Companies**]
4) [**US Frame Factory**]
5) <**Insert manufacturer's name**>

c. Inner Track Flange Length: [2 inches (51 mm)]<**Insert dimension**> .

G. Firestop Track: Top track manufactured to allow partition heads to expand and contract with movement of structure above while maintaining continuity of fire-resistance-rated assembly indicated on Drawings; in base-steel thickness not less than that of studs and in width to accommodate depth of studs.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**Fire Trak Corp**]
d. [**Marino\WARE**]
e. [**Metal-Lite**]
f. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
g. [**Steel Construction Systems; Stone Group of Companies**]
h. [**Steel Network, Inc. (The)**]
i. [**TELLING Industries**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**Fire Trak Corp**]
d. [**Marino\WARE**]
e. [**Metal-Lite**]
f. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
g. [**Steel Construction Systems; Stone Group of Companies**]
h. [**Steel Network, Inc. (The)**]
i. [**TELLING Industries**]
j. <**Insert manufacturer's name**>

H. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**Jaimes Industries, Inc.**]
d. [**Marino\WARE**]
e. [**MBA Building Supplies**]
f. [**MRI Steel Framing, LLC**]
g. [**Phillips Manufacturing Co**]
h. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
i. [**Steel Construction Systems; Stone Group of Companies**]
j. [**Steel Network, Inc. (The)**]

k. [**TELLING Industries**]
l. [**The Mill Steel Co**]
m. [**US Frame Factory**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**Jaimes Industries, Inc.**]
d. [**Marino\WARE**]
e. [**MBA Building Supplies**]
f. [**MRI Steel Framing, LLC**]
g. [**Phillips Manufacturing Co**]
h. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
i. [**Steel Construction Systems; Stone Group of Companies**]
j. [**Steel Network, Inc. (The)**]
k. [**TELLING Industries**]
l. [**The Mill Steel Co**]
m. [**US Frame Factory**]
n. <**Insert manufacturer's name**>

3. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**0.0179 inch (0.455 mm)**][**0.0269 inch (0.683 mm)**][**0.0296 inch (0.752 mm)**][**0.0329 inch (0.836 mm)**]<**Insert thickness**> .

I. U-Channel: Cold-rolled steel, **0.0538-inch (1.367-mm)** minimum base-steel thickness, with minimum **1/2-inch- (13-mm-)** wide flanges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MRI Steel Framing, LLC**]
h. [**Phillips Manufacturing Co**]
i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
j. [**Steel Construction Systems; Stone Group of Companies**]
k. [**Steel Network, Inc. (The)**]
l. [**TELLING Industries**]
m. [**The Mill Steel Co**]
n. [**UMS Metal Building Systems USA LLC**]
o. [**US Frame Factory**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MRI Steel Framing, LLC**]
h. [**Phillips Manufacturing Co**]
i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
j. [**Steel Construction Systems; Stone Group of Companies**]
k. [**Steel Network, Inc. (The)**]
l. [**TELLING Industries**]
m. [**The Mill Steel Co**]
n. [**UMS Metal Building Systems USA LLC**]
o. [**US Frame Factory**]
p. <**Insert manufacturer's name**>

3. Depth:

a. Bridging: [**As indicated on Drawings**][**1-1/2 inches (38 mm)**]<**Insert dimension**> .
b. Suspended-Assembly Carrying Channels (Main Runners): [**As indicated on Drawings**][**2-1/2 inches (64 mm)**][**2 inches (51 mm)**][**1-1/2 inches (38 mm)**]<**Insert dimension**> .
c. Suspended-Assembly Furring Channels (Furring Members): [**3/4 inch (19 mm)**]<**Insert dimension**> .

4. Bridging Clip Angle: Not less than **1-1/2 by 1-1/2 inches (38 by 38 mm)**; **0.068-inch- (1.73-mm-)** base-steel thickness.

J. Rigid Hat-Shaped Furring Channels: Conventional members, roll-formed into standard shapes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MBA Metal Framing**]
h. [**MRI Steel Framing, LLC**]
i. [**Phillips Manufacturing Co**]
j. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
k. [**Steel Construction Systems; Stone Group of Companies**]
l. [**Steel Network, Inc. (The)**]
m. [**TELLING Industries**]
n. [**The Mill Steel Co**]
o. [**UMS Metal Building Systems USA LLC**]
p. [**US Frame Factory**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MBA Metal Framing**]
h. [**MRI Steel Framing, LLC**]
i. [**Phillips Manufacturing Co**]
j. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
k. [**Steel Construction Systems; Stone Group of Companies**]
l. [**Steel Network, Inc. (The)**]
m. [**TELLING Industries**]
n. [**The Mill Steel Co**]
o. [**UMS Metal Building Systems USA LLC**]
p. [**US Frame Factory**]
q. <**Insert manufacturer's name**>

3. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**0.0179 inch (0.455 mm)**][**0.0296 inch (0.752 mm)**][**0.0329 inch (0.836 mm)**]<**Insert thickness**> .
4. Depth: [**As indicated on Drawings**][**7/8 inch (22.2 mm)**][**1-1/2 inches (38 mm)**]<**Insert requirements**> .

K. Resilient Furring Channels: **1/2-inch- (13-mm-)** deep, steel sheet members designed to reduce sound transmission.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MRI Steel Framing, LLC**]
h. [**Phillips Manufacturing Co**]
i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
j. [**Steel Construction Systems; Stone Group of Companies**]
k. [**Steel Network, Inc. (The)**]
l. [**TELLING Industries**]
m. [**The Mill Steel Co**]
n. [**US Frame Factory**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]

d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MRI Steel Framing, LLC**]
h. [**Phillips Manufacturing Co**]
i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
j. [**Steel Construction Systems; Stone Group of Companies**]
k. [**Steel Network, Inc. (The)**]
l. [**TELLING Industries**]
m. [**The Mill Steel Co**]
n. [**US Frame Factory**]
o. <**Insert manufacturer's name**>

3. Configuration: [**Asymmetrical**][**or**][**hat shaped**] .

L. Z-Shaped Furring: With slotted or nonslotted web, face flange of **1-1/4 inches (32 mm)**, wall attachment flange of **3/4 inch (19 mm)**, minimum base-steel thickness of **0.0179 inch (0.455 mm)**, and depth required to fit insulation thickness indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MBA Metal Framing**]
h. [**MRI Steel Framing, LLC**]
i. [**Phillips Manufacturing Co**]
j. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
k. [**Steel Construction Systems; Stone Group of Companies**]
l. [**Steel Network, Inc. (The)**]
m. [**TELLING Industries**]
n. [**The Mill Steel Co**]
o. [**US Frame Factory**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MBA Metal Framing**]
h. [**MRI Steel Framing, LLC**]
i. [**Phillips Manufacturing Co**]
j. [**SCAFCO Steel Stud Company; Stone Group of Companies**]

k. [**Steel Construction Systems; Stone Group of Companies**]
l. [**Steel Network, Inc. (The)**]
m. [**TELLING Industries**]
n. [**The Mill Steel Co**]
o. [**US Frame Factory**]
p. <**Insert manufacturer's name**>

2.3 Auxiliary Materials - Steel Framing Connectors

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.4 GRID SUSPENSION SYSTEMS

A. Grid Suspension Systems for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Armstrong World Industries**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Rockfon; ROCKWOOL International**]
d. [**USG Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong World Industries**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Rockfon; ROCKWOOL International**]
d. [**USG Corporation**]
e. <**Insert manufacturer's name**>

2.5 Flexible Backing Plate

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Adjustable Wall-Furring Brackets: Steel sheet in minimum **0.0329-inch- (0.836-mm-)** base-steel thickness with serrated edges for attaching furring channels to exterior masonry or concrete walls.

1. Protective Coating: ASTM A653/A653M, [**G40 (Z120)**][**or**][**G60 (Z180)**] , hot-dip galvanized.

C. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.

1. Tire Wire for Adjustable Wall-Furring Brackets: Use minimum double strand of **0.0625-inch- (1.59-mm-)** diameter wire, or triple strand of **0.0475-inch- (1.21-mm-)** diameter wire to attach furring channels.
2. Tire Wire for Suspended-Ceiling Systems:

a. Splicing Carrying Channels and Furring Members: Use double loops of minimum **0.0625-inch- (1.59-mm-)** diameter wire.
b. Saddle Tying Main Runners and Cross Furring: Use minimum **0.0625-inch- (1.59-mm-)** diameter wire, or double strand of **0.0475-inch- (1.21-mm-)** diameter wire.

D. Post-Installed Anchors: Fastener systems with an evaluation report, acceptable to authorities having jurisdiction, as appropriate for the substrate.

1. Securing Hangers:

a. Acceptance Criteria: ICC-ES [**AC01**][**AC193**][**AC58**][**or**][**AC308**] .
b. Type: [**Torque-controlled, expansion anchor**][**torque-controlled, adhesive anchor**][**or**][**adhesive anchor**] .
c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated on Drawings.
d. Stainless Steel Material for Exterior or Interior Locations: Alloy [**Group 1 (A1)**][**Group 2 (A4)**] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

E. Power-Actuated Anchors: Fastener systems with an evaluation report, acceptable to authorities having jurisdiction, based on ICC-ES AC70.

F. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper.

1. Diameter: [**0.162 inch (4.12 mm)**]<**Insert dimension**> .

G. Flat Hangers: Steel sheet.

1. Protective Coating: ASTM A653/A653M, [**G40 (Z120)**][**or**][**G60 (Z180)**] , hot-dip galvanized.
2. Size and Length: [**In size indicated on Drawings**][**1 by 3/16 inch (25 by 5 mm) by length indicated on Drawings**]<**Insert dimensions**> .

H. Isolation Strip at Exterior Walls: Provide [**one of**] the following:

1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, **1/8 inch (3.2 mm)** thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, substrates, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices required to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling track to surfaces indicated on Drawings to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than **24 inches (610 mm)** o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of nonstructural steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated on Drawings. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION OF NONSTRUCTURAL STEEL FRAMING, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with framing members. Frame both sides of joints independently.

3.4 INSTALLATION OF NONSTRUCTURAL STEEL FRAMING

A. Install framing system components at spacings indicated on Drawings, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: [**As required by horizontal deflection performance requirements**][**16 inches (406 mm) o.c.**][**24 inches (610 mm) o.c.**] unless otherwise indicated on Drawings.
2. Multilayer Application: [**As required by horizontal deflection performance requirements**][**16 inches (406 mm) o.c.**][**24 inches (610 mm) o.c.**] unless otherwise indicated on Drawings.
3. Tile Backing Panels: [**As required by horizontal deflection performance requirements**][**16 inches (406 mm) o.c.**] unless otherwise indicated on Drawings.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install track at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated on Drawings to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated on Drawings.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum **1/2-inch (13-mm)** clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure unless otherwise indicated on Drawings.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated on Drawings. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated on Drawings and support closures to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Install to maintain continuity of fire-resistance-rated assembly indicated on Drawings.

5. STC-Rated Partitions: Install framing to comply with STC-rated assembly indicated on Drawings.
6. Curved Partitions:

    a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of at least two studs at ends of arcs, place studs **6 inches (152 mm)** o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or

powder-driven fasteners spaced **24 inches (610 mm)** o.c.

F. Adjustable Wall-Furring Brackets: Install brackets with serrated edges facing upward spaced at minimum **48 inches (1219 mm)** o.c. vertically with **6 inches (152 mm)** maximum from floor and ceiling, and minimum **36 inches (914 mm)** o.c. horizontally with **4 inches (102 mm)** maximum from abutting construction, unless otherwise indicated on Drawings.

G. Z-Shaped Furring:

1. Install insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced [**24 inches (610 mm)**]<**Insert dimension**> o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (610 mm)** o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than **12 inches (305 mm)** from corner and cut insulation to fit.

H. Suspended Assemblies: Isolate suspension assemblies from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

1. Hangers: Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system spaced [**as indicated on Drawings**]<**Insert requirements**> .

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
    b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

        1) Size supplemental suspension members and hangers to support ceiling loads within [**performance limits established by referenced installation standards**]<**Insert deflection limit**> .

    c. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
    d. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
    e. Do not attach hangers to steel roof deck.
    f. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
    g. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
    h. Do not connect or suspend framing from ducts, pipes, or conduit.

2. U-Channels: Carrying channels (main runners) spaced [**as indicated on Drawings**]<**Insert requirements**> .
3. Furring Channels (Furring Members): [**As indicated on Drawings**][**U-channels**][**Studs and track**][**High-strength steel studs and track**][**Rigid hat-shaped furring channels**][**Resilient furring channels**]<**Insert requirements**> .

a. Spacing: [**As indicated on Drawings**]<**Insert requirements**> .
b. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

4. Seismic Bracing: Sway-brace suspension systems [**with hangers used for support**]<**Insert requirements**> .

I. Installation Tolerances for Nonstructural Steel Framing:

1. Framing Members: Install each framing member so fastening surfaces vary not more than **1/8 inch (3.2 mm)** from the plane formed by faces of adjacent framing.
2. Suspended Assemblies: Install suspension systems that are level to within [**1/8 inch in 12 ft. (3.2 mm in 3.7 m)**]<**Insert dimensions**> measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.5 INSTALLATION OF GRID SUSPENSION SYSTEMS

A. Grid Suspension Systems: Install in accordance with manufacturer's written instructions. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

B. Installation Tolerances for Grid Suspension Systems: Install suspension systems that are level to within [**1/8 inch in 12 ft. (3.2 mm in 3.7 m)**]<**Insert dimensions**> measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16 00

Task	Specification	Specification Description
09 22 16 13	09 22 16 00	Non-Structural Metal Framing
09 22 36 13	09 23 00 00	Gypsum Plastering
09 22 36 23	09 23 00 00	Gypsum Plastering
09 22 36 33	09 23 00 00	Gypsum Plastering

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SECTION 09 23 00 00 - GYPSUM PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Expanded metal lath.
2. Accessories.
3. Base-coat gypsum plaster materials.
4. Finish-coat gypsum plaster materials.

B. Related Requirements:

1. Section 092613 "Gypsum Veneer Plastering" for gypsum-based veneer plaster applied on gypsum base for veneer plaster, unit masonry, and monolithic concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: Locations and installation of control and expansion joints, including plans, elevations, sections, and attachment details.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for each substrate and finish texture indicated for gypsum plastering, including accessories.

a. Size: [**100 sq. ft.** (**9 sq. m**)]<**Insert dimension**> in surface area.

2. Simulate finished lighting conditions for review of mockups.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, contamination, corrosion, construction traffic, and other causes.

1.6 FIELD CONDITIONS

A. Comply with ASTM C842 requirements or gypsum plaster manufacturer's written instructions, whichever are more stringent.

B. Room Temperatures: Maintain temperatures at not less than **55 deg F (13 deg C)** or greater than **80 deg F (27 deg C)** for at least seven days before application of gypsum plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.

C. Avoid conditions that result in gypsum plaster drying out too quickly.

1. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
2. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
3. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain base- and finish-coat plasters from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Where indicated on Drawings, provide gypsum plaster assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by a qualified testing agency.

B. Sound-Transmission Characteristics: Where indicated on Drawings, provide gypsum plaster assemblies identical to those of assemblies tested for STC ratings in accordance with ASTM E90 and classified in accordance with ASTM E413 by a qualified testing agency.

2.3 EXPANDED METAL LATH

A. Expanded Metal Lath: ASTM C847; cold-rolled carbon-steel sheet, hot-dip galvanized with ASTM A653/A653M **G60 (Z180)** zinc coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AMICO, a Gibraltar Industries company**]
    b. [**CEMCO; California Expanded Metal Products Co.**]
    c. [**ClarkDietrich**]
    d. [**Marino\WARE**]
    e. [**Phillips Manufacturing Co**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**AMICO, a Gibraltar Industries company**]
    b. [**CEMCO; California Expanded Metal Products Co.**]
    c. [**ClarkDietrich**]
    d. [**Marino\WARE**]
    e. [**Phillips Manufacturing Co**]
    f. <**Insert manufacturer's name**>

3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**]<**Insert value**> percent.
4. Flat Diamond-Mesh Lath: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**], unbacked.
5. Self-Furring Diamond-Mesh Lath: [**V-grooved**][**Dimpled**].

    a. Weight: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**].
    b. Paper Backing: Kraft paper factory bonded to back of lath.

6. 3/8-Inch (10-mm) Rib Lath: [**3.4 lb/sq. yd. (1.8 kg/sq. m)**][**4 lb/sq. yd. (2.2 kg/sq. m)**].

    a. Paper Backing: Kraft paper factory bonded to back of lath.

2.4 ACCESSORIES

A. General: Comply with requirements in ASTM C841, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AMICO, a Gibraltar Industries company**]
    b. [**CEMCO; California Expanded Metal Products Co.**]
    c. [**ClarkDietrich**]
    d. [**Marino\WARE**]
    e. [**Phillips Manufacturing Co**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**AMICO, a Gibraltar Industries company**]
b. [**CEMCO; California Expanded Metal Products Co.**]
c. [**ClarkDietrich**]
d. [**Marino\WARE**]
e. [**Phillips Manufacturing Co**]
f. <**Insert manufacturer's name**>

3. Cornerite: Fabricated from expanded metal lath, hot-dip galvanized with ASTM A653/A653M **G60 (Z180)** zinc coating.
4. Striplath: Fabricated from expanded metal lath, hot-dip galvanized with ASTM A653/A653M **G60 (Z180)** zinc coating.
5. Cornerbeads: Fabricated from [**zinc**][**or**][**zinc-coated (galvanized) steel**].

a. Smallnose cornerbead with expanded flanges; use [**unless otherwise indicated**][**at locations indicated on Drawings**]<**Insert requirements**>.
b. Smallnose cornerbead with perforated flanges; use [**on curved corners**][**at locations indicated on Drawings**]<**Insert requirements**>.
c. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use [**on columns and for finishing unit masonry corners**][**at locations indicated on Drawings**]<**Insert requirements**>.
d. Bullnose cornerbead, radius **3/4-inch (19-mm)** minimum, with expanded flanges; use [**unless otherwise indicated**][**at locations indicated on Drawings**]<**Insert requirements**>.

6. Casing Beads: Fabricated from [**zinc**][**or**][**zinc-coated (galvanized) steel**]; square-edged style; with expanded flanges.
7. Control Joints: Fabricated from [**zinc**][**or**][**zinc-coated (galvanized) steel**]; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
8. One-Piece Expansion Joints: Fabricated from [**zinc**][**or**][**zinc-coated (galvanized) steel**]; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
9. Two-Piece Expansion Joints: Fabricated from [**zinc**][**or**][**zinc-coated (galvanized) steel**]; formed to produce slip-joint and square-edged reveal that is adjustable from **1/4 to 5/8 inch (6 to 16 mm)** wide; with perforated flanges.

C. Plastic Accessories: Manufactured from high-impact PVC.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMICO, a Gibraltar Industries company**]
b. [**ClarkDietrich**]
c. [**Plastic Components, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMICO, a Gibraltar Industries company**]

b. [**ClarkDietrich**]
c. [**Plastic Components, Inc**]
d. <**Insert manufacturer's name**>

3. Cornerbeads: With perforated flanges.

a. Smallnose cornerbead; use [**unless otherwise indicated**][**at locations indicated on Drawings**]<**Insert requirements**>.
b. Bullnose cornerbead, radius **3/4-inch (19-mm)** minimum; use [**unless otherwise indicated**][**at locations indicated on Drawings**]<**Insert requirements**>.

4. Casing Beads: Square-edge style, with perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
5. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
6. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged [**1/2-inch- (13-mm-)**][**1-inch- (25-mm-)**][**1-1/2-inch- (38-mm-)**]<**Insert dimension**> wide reveal; with perforated concealed flanges.
7. Termination Reveal Trim: F-shaped, one-piece trim, formed to produce a [**1/2-inch- (13-mm-)**][**3/4-inch- (19-mm-)**][**1-inch- (25-mm-)**]<**Insert dimension**> wide reveal at the termination of plaster where it abuts other materials; with single, perforated concealed flange.

D. Aluminum Trim: Extruded accessories of profiles and dimensions indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brand X Metals, Inc**]
b. [**Flannery, Inc.**]
c. [**Fry Reglet Corporation**]
d. [**Gordon Inc.**]
e. [**Pittcon Industries**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brand X Metals, Inc**]
b. [**Flannery, Inc.**]
c. [**Fry Reglet Corporation**]
d. [**Gordon Inc.**]
e. [**Pittcon Industries**]
f. <**Insert manufacturer's name**>

3. Aluminum: Alloy and temper with not less than the strength and durability properties of **ASTM B221 (ASTM B221M)**, Alloy 6063-T5.
4. Finish: [**Mill**][**Chemical-conversion coating, ASTM D1730, Type B, compatible with field-applied finish coatings specified**]<**Insert requirements**>.

2.5 BASE-COAT GYPSUM PLASTER MATERIALS

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not

less than <**Insert value**> percent.

B. Lightweight-Gypsum Ready-Mixed Plaster: ASTM C28/C28M, with factory-mixed perlite aggregate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   b. [**USG Corporation**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   b. [**USG Corporation**]
   c. <**Insert manufacturer's name**>

C. Gypsum Neat Plaster: ASTM C28/C28M, for use with job-mixed aggregates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   b. [**USG Corporation**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   b. [**USG Corporation**]
   c. <**Insert manufacturer's name**>

D. Gypsum Wood-Fibered Plaster: ASTM C28/C28M, for use as is or with the addition of job-mixed sand in up to equal proportions by weight.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**USG Corporation**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**USG Corporation**]
b. <**Insert manufacturer's name**>

E. High-Strength Gypsum Neat Plaster: ASTM C28/C28M, with a minimum, average, dry compressive strength of **2800 psi (19 MPa)** in accordance with ASTM C472 for a mix of **100 lb (45 kg)** of plaster and **2 cu. ft. (0.06 cu. m)** of sand.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**USG Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**USG Corporation**]
b. <**Insert manufacturer's name**>

F. Aggregates for Base-Coat Plasters: ASTM C35, [**sand**][**and**][**perlite**].

2.6 FINISH-COAT GYPSUM PLASTER MATERIALS

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

B. Gypsum Gauging Plaster: ASTM C28/C28M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]
c. <**Insert manufacturer's name**>

C. Gypsum Ready-Mixed Finish Plaster: Manufacturer's standard, factory-mixed, gaged, interior finish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**USG Corporation**]
c. <**Insert manufacturer's name**>

D. High-Strength Gypsum Gauging Plaster: ASTM C28/C28M, with a minimum, average, dry compressive strength of **5000 psi (34 MPa)** in accordance with ASTM C472 for a neat mix.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**USG Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**USG Corporation**]
b. <**Insert manufacturer's name**>

E. Gypsum Keene's Cement: ASTM C61/C61M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**USG Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**USG Corporation**]
b. <**Insert manufacturer's name**>

F. Lime: ASTM C206, [**Type S, special**][**or**][**Type N, normal**] finishing hydrated lime.

G. Aggregates for Float Finishes: ASTM C35, [**sand**][**and**][**perlite for finish coats over base coats containing perlite**]; graded in accordance with ASTM C842.

2.7 MISCELLANEOUS MATERIALS

A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

B. Bonding Compound: ASTM C631; recommended by plaster manufacturer for application indicated.

C. Fasteners for Attaching Metal Lath to Substrates: ASTM C841.

D. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than **0.0475-inch (1.21-mm)** diameter unless otherwise indicated.

E. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of rated assembly.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**]<**Insert value**> percent.

F. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

G. Mix Additives: Use gypsum plaster accelerator and retarder products of plaster manufacturer if required by Project conditions. Use only additives that plaster manufacturer recommends in writing for use with plaster to which it is added.

2.8 PLASTER MIXES

A. Mixing: Comply with ASTM C842 and manufacturer's written instructions for applications indicated.

B. Mix Additives: Use accelerators and retarders, if required by Project conditions, in accordance with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Reject plaster materials that are wet or moisture damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

3.3 INSTALLATION, GENERAL

A. Fire-Resistance-Rated Assemblies: Install components in accordance with requirements for design designations from listing organization and publication indicated on Drawings.

B. STC-Rated Assemblies: Install components in accordance with requirements for design designations from listing organization and publication indicated on Drawings.

C. Sound-Attenuation Blankets: Where [**indicated on Drawings**][**and**][**required by design designations from listing organization and publication indicated on Drawings**], install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.

D. Acoustical Sealant: Where [**indicated on Drawings**][**and**][**required by design designations from listing organization and publication indicated on Drawings**], seal joints between edges of plasterwork and abutting construction with acoustical sealant.

3.4 INSTALLATION OF EXPANDED METAL LATH

A. Expanded Metal Lath: Install in accordance with ASTM C841.

1. Partition Framing and Vertical Furring: Install flat diamond-mesh lath.
2. Flat-Ceiling and Horizontal Framing: Install [**flat diamond-mesh**][**3/8-inch (10-mm) rib**] lath.
3. Curved-Ceiling Framing: Install flat diamond-mesh lath.
4. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.
5. Channel-Stud Solid-Plaster Partitions: Where supported by channel studs and L-runners, install flat diamond-mesh lath.
6. Studless Solid-Plaster Partitions: Where supported by L-runners, install **3/8-inch (10-mm)** rib lath.

3.5 INSTALLATION OF ACCESSORIES

A. General: Install in accordance with ASTM C841.

B. Cornerbeads: Install at external corners.

C. Casing Beads: Install at terminations of plasterwork, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or frames act as casing beads.

D. Control Joints: Locate as approved by Architect for visual effect and as follows:

1. With spacing between joints in either direction not exceeding the following:

   a. Partitions: **30 ft. (9 m)**.
   b. Ceilings: [**50 ft. (15 m)**][**30 ft. (9 m)**].

2. Where furred or suspended ceilings abut columns, walls, beams, or other vertical elements.
3. Where ceiling framing or furring changes direction.
4. Where control joints occur in supporting construction.

E. Expansion Joints: Locate where an expansion joint occurs in supporting construction.

F. Aluminum Trim: Install in accordance with manufacturer's written instructions.

3.6 APPLICATION OF PLASTER

A. General: Comply with ASTM C842.

1. Do not deviate more than plus or minus **1/8 inch in 10 ft. (3 mm in 3 m)** from a true plane in finished plaster surfaces when measured by a **10-ft. (3-m)** straightedge placed on surface.
2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.

B. Bonding Compound: Apply on [**unit masonry**][**and**][**monolithic concrete**] substrates for direct application of plaster.

3.7 INSTALLATION OF BASE-COAT GYPSUM PLASTER MATERIALS

A. Over Expanded Metal Lath:

1. Scratch Coat: [**Gypsum neat plaster with job-mixed sand**][**Gypsum wood-fibered plaster; neat or with job-mixed sand**][**High-strength gypsum neat plaster with job-mixed sand**]<**Insert requirements**>.
2. Brown Coat: [**Lightweight-gypsum ready-mixed plaster**][**Gypsum neat plaster with job-mixed sand**][**Gypsum neat plaster with job-mixed perlite**][**Gypsum wood-fibered plaster with job-mixed sand**][**High-strength gypsum neat plaster with job-mixed sand**]<**Insert requirements**>.

B. Over Unit Masonry: [**Lightweight-gypsum ready-mixed plaster**][**Wood-fibered gypsum plaster with job-mixed sand**][**Gypsum neat plaster with job-mixed sand**]<**Insert requirements**>.

C. Over Monolithic Concrete: [**Gypsum neat plaster with job-mixed sand**]<**Insert requirements**>.

3.8 INSTALLATION OF FINISH-COAT GYPSUM PLASTER MATERIALS

A. Smooth-Troweled Finishes:

1. Materials: [**Gypsum gauging plaster and lime putty**][**Gypsum ready-mixed finish plaster**][**High-strength gypsum gauging plaster and lime putty**][**Gypsum Keene's cement and lime putty**]<**Insert requirements**>.
2. Locations: Provide smooth-troweled finish [**unless otherwise indicated**][**where indicated on Drawings**]<**Insert locations**>.

B. Float Finishes:

1. Materials: [**Gypsum gauging plaster and lime putty**][**Gypsum Keene's cement and lime putty**]<**Insert requirements**>.
2. Locations: Provide float finish [**unless otherwise indicated**][**where indicated on Drawings**]<**Insert locations**>.

C. Sprayed Finishes: [**Match Architect's sample**]<**Insert requirements**>.

1. Materials: [**Gypsum ready-mixed finish plaster**]<**Insert requirements**>.
2. Locations: Provide sprayed finish [**unless otherwise indicated**][**where indicated on**

Drawings]<**Insert locations**>.

D. Textured Finishes: [**Match Architect's sample**]<**Insert requirements**>.

1. Materials: [**Gypsum ready-mixed finish plaster**]<**Insert requirements**>.
2. Locations: Provide textured finish [**unless otherwise indicated**][**where indicated on Drawings**]<**Insert locations**>.

E. Concealed Plaster:

1. Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
2. Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.
3. Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.

3.9 REPAIR

A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.10 CLEANING

A. Remove temporary protection and enclosure of other work after plastering is complete.

B. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.

C. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 23 00 00

Task	Specification	Specification Description
09 23 13 00	09 23 00 00	Gypsum Plastering

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SECTION 09 24 00 00 - CEMENT PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal lath.
2. Accessories.
3. Base-coat cement plaster.
4. Cement plaster finish coats.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: Locations and installation of control and expansion joints, including plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For each type of factory-prepared finish coat and for each color and finish texture specified.

D. Samples for Verification: For each type of factory-prepared finish coat and for each color and finish texture specified, **12 by 12 inches (305 by 305 mm)**, and prepared on rigid backing.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

1.4 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for each substrate and color and finish texture indicated for cement plastering, including accessories.

a. Size: [**100 sq. ft. (9 sq. m)**]<**Insert dimension**> in surface area.

2. For interior plasterwork, simulate finished lighting conditions for review of mockups.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.6 FIELD CONDITIONS

A. Comply with ASTM C926 requirements.

B. Exterior Plasterwork:

1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
2. Apply plaster when ambient temperature is greater than **40 deg F (4.4 deg C)**.
3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.

C. Interior Plasterwork: Maintain room temperatures at greater than **40 deg F (4.4 deg C)** for at least 48 hours before plaster application, and continuously during and after application.

1. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
2. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

D. Factory-Prepared Finish Coats: Comply with manufacturer's written instructions for environmental conditions for applying finish coats.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Where indicated on Drawings, provide cement plaster assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by a qualified testing agency.

2.2 METAL LATH

A. Expanded Metal Lath: ASTM C847; cold-rolled carbon steel sheet, hot-dip galvanized with ASTM A653/A653M [**G60 (Z180)**][**G90 (Z275)**] zinc coating.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AMICO, a Gibraltar Industries company**]
    b. [**CEMCO; California Expanded Metal Products Co.**]
    c. [**ClarkDietrich**]
    d. [**Marino\WARE**]
    e. [**Phillips Manufacturing Co**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**AMICO, a Gibraltar Industries company**]
    b. [**CEMCO; California Expanded Metal Products Co.**]
    c. [**ClarkDietrich**]
    d. [**Marino\WARE**]
    e. [**Phillips Manufacturing Co**]
    f. <**Insert manufacturer's name**>

3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**]<**Insert value**> percent.
4. Flat Diamond-Mesh Lath: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**].

    a. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and with [**10-minute**][**60-minute**] water resistance.

        1) Provide water-resistive barrier [**at exterior locations**][**where indicated on Drawings**]<**Insert requirements**>.

5. Self-Furring Diamond-Mesh Lath: [**V-grooved**][**Dimpled**].

    a. Weight: [**2.5 lb/sq. yd. (1.4 kg/sq. m)**][**3.4 lb/sq. yd. (1.8 kg/sq. m)**].
    b. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and with [**10-minute**][**60-minute**] water resistance.

        1) Provide water-resistive barrier [**at exterior locations**][**where indicated on Drawings**]<**Insert requirements**>.

    c. Kraft-Paper Backing: Factory bonded to back of lath.

        1) Provide kraft-paper backing [**at interior locations**][**where indicated on Drawings**]<**Insert requirements**>.

6. 3/8-Inch (10-mm) Rib Lath: [**3.4 lb/sq. yd. (1.8 kg/sq. m)**][**4 lb/sq. yd. (2.2 kg/sq. m)**].

    a. Kraft-Paper Backing: Factory bonded to back of lath.

B. Wire-Fabric Lath:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ClarkDietrich**]
b. [**Davis Wire; a Heico Wire Group company**]
c. [**K-Lath; a Tree Island Steel Ltd. company**]
d. [**Structa Wire Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ClarkDietrich**]
b. [**Davis Wire; a Heico Wire Group company**]
c. [**K-Lath; a Tree Island Steel Ltd. company**]
d. [**Structa Wire Corp.**]
e. <**Insert manufacturer's name**>

3. Welded-Wire Lath: ASTM C933; self-furring, [**1.14 lb/sq. yd. (0.6 kg/sq. m)**][**1.95 lb/sq. yd. (1.1 kg/sq. m)**].
4. Woven-Wire Lath: ASTM C1032; self-furring, with stiffener wires, **1.4 lb/sq. yd. (0.8 kg/sq. m)**, with **1.5-inch (38-mm)** openings, and woven from **0.051-inch (1.30-mm)** diameter wire.
5. Water-Resistive Barrier: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and [**in double layer, each having 10-minute**][**with 10-minute**][**with 60-minute**] water resistance.

a. Provide water-resistive barrier [**at exterior locations**][**where indicated on Drawings**]<**Insert requirements**>.

2.3 ACCESSORIES

A. General: Comply with requirements in ASTM C1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMICO, a Gibraltar Industries company**]
b. [**Brand X Metals, Inc**]
c. [**CEMCO; California Expanded Metal Products Co.**]
d. [**ClarkDietrich**]
e. [**Flannery, Inc.**]
f. [**Marino\WARE**]
g. [**Phillips Manufacturing Co**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**AMICO, a Gibraltar Industries company**]
b. [**Brand X Metals, Inc**]
c. [**CEMCO; California Expanded Metal Products Co.**]
d. [**ClarkDietrich**]
e. [**Flannery, Inc.**]
f. [**Marino\WARE**]
g. [**Phillips Manufacturing Co**]
h. <**Insert manufacturer's name**>

3. Foundation Weep Screed: Fabricated from hot-dip-galvanized steel sheet with ASTM A653/A653M [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
4. Cornerite: Fabricated from metal lath, hot-dip galvanized with ASTM A653/A653M [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
5. External- (Outside-) Corner Reinforcement: Fabricated from metal lath, hot-dip galvanized with ASTM A653/A653M [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
6. Cornerbeads: Fabricated from [**zinc**][**zinc-coated (galvanized) steel**][**or**][**anodized aluminum**].

   a. Smallnose cornerbead with expanded flanges; use [**unless otherwise indicated**][**at locations indicated on Drawings**]<**Insert requirements**>.
   b. Smallnose cornerbead with perforated flanges; use [**on curved corners**][**at locations indicated on Drawings**]<**Insert requirements**>.
   c. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use [**on columns and for finishing unit masonry corners**][**at locations indicated on Drawings**]<**Insert requirements**>.
   d. Bullnose cornerbead, radius **3/4-inch (19-mm)** minimum, with expanded flanges; use [**unless otherwise indicated**][**at locations indicated on Drawings**]<**Insert requirements**>.

7. Casing Beads: Fabricated from [**zinc**][**zinc-coated (galvanized) steel**][**or**][**anodized aluminum**]; square-edged style; with expanded flanges.
8. Control Joints: Fabricated from [**zinc**][**or**][**zinc-coated (galvanized) steel**]; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
9. One-Piece Expansion Joints: Fabricated from [**zinc**][**or**][**zinc-coated (galvanized) steel**]; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
10. Two-Piece Expansion Joints: Fabricated from [**zinc**][**zinc-coated (galvanized) steel**][**or**][**anodized aluminum**]; formed to produce slip-joint and square-edged reveal that is adjustable from **1/4 to 5/8 inch (6 to 16 mm)** wide; with perforated flanges.

C. Plastic Accessories: Manufactured from high-impact PVC.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMICO, a Gibraltar Industries company**]
   b. [**ClarkDietrich**]
   c. [**Plastic Components, Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMICO, a Gibraltar Industries company**]
b. [**ClarkDietrich**]
c. [**Plastic Components, Inc**]
d. <**Insert manufacturer's name**>

3. Cornerbeads: With perforated flanges.

a. Smallnose cornerbead; use [**unless otherwise indicated**][**at locations indicated on Drawings**]<**Insert requirements**>.
b. Bullnose cornerbead, radius **3/4-inch (19-mm)** minimum; use [**unless otherwise indicated**][**at locations indicated on Drawings**]<**Insert requirements**>.

4. Casing Beads: Square-edge style, with perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
5. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.
6. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged [**1/2-inch- (13-mm-)**][**1-inch- (25-mm-)**][**1-1/2-inch- (38-mm-)**]<**Insert dimension**> wide reveal; with perforated concealed flanges.

2.4 BASE-COAT CEMENT PLASTER

A. General: Comply with requirements in ASTM C926 for applications indicated.

1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed **1 lb of fiber/cu. yd. (0.6 kg of fiber/cu. m)** of cementitious materials.
2. Aggregate:

a. Sand: Use [**unless otherwise indicated**]<**Insert requirements**>.
b. Perlite: Use [**where required by fire-resistance-rated design designations from listing organization and publication indicated on Drawings**]<**Insert requirements**>.

B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:

1. Portland Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part portland cement and [**0 to 3/4**][**3/4 to 1-1/2**] parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part portland cement and [**0 to 3/4**][**3/4 to 1-1/2**] parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

2. Masonry Cement Mixes:

a. Scratch Coat: Mix 1 part masonry cement and 2-1/2 to 4 parts aggregate.
b. Brown Coat: Mix 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.

3. Portland and Masonry Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.

b. Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

4. Plastic Cement Mixes:

a. Scratch Coat: Mix 1 part plastic cement and 2-1/2 to 4 parts aggregate.
b. Brown Coat: Mix 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.

5. Portland and Plastic Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

C. Base-Coat Mix for Use over Solid Plaster Bases: Single base (scratch) coat for two-coat plasterwork as follows:

1. Low-Absorption Unit Masonry and Concrete Substrates:

a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

2. High-Absorption Unit Masonry and Concrete Substrates:

a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.
c. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
d. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

2.5 CEMENT PLASTER FINISH COATS

A. Job-Mixed Finish-Coat Mix: Comply with requirements in ASTM C926.

1. Aggregates:

a. Sand: Use over base coats containing sand.
b. Perlite: Use over base coats containing perlite.
c. Exposed Aggregates: Use [**where indicated on Drawings**]<**Insert requirements**>.

2. Portland Cement Mix: For cementitious material, mix 1 part portland cement and [**3/4 to 1-1/2**][**1-1/2 to 2**] parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
3. Masonry Cement Mix: Use 1 part masonry cement and 1-1/2 to 3 parts aggregate.
4. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.

5. Plastic Cement Mix: Use 1 part plastic cement and 1-1/2 to 3 parts aggregate.

B. Ready-Mixed Finish-Coat Plaster: Factory-mixed portland cement, aggregates, coloring agents, and proprietary ingredients.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Stucco Products Corp.**]
   b. [**El Rey Stucco Solutions; a Parex USA, Inc. brand**]
   c. [**Florida Stucco**]
   d. [**Omega Products International, Inc.**]
   e. [**Parex, a Sika brand**]
   f. [**Quikrete; The QUIKRETE Companies, LLC**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**California Stucco Products Corp.**]
   b. [**El Rey Stucco Solutions; a Parex USA, Inc. brand**]
   c. [**Florida Stucco**]
   d. [**Omega Products International, Inc.**]
   e. [**Parex, a Sika brand**]
   f. [**Quikrete; The QUIKRETE Companies, LLC**]
   g. <**Insert manufacturer's name**>

3. Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.
4. Source Limitations: Obtain ready-mixed finish-coat plaster from single source from single manufacturer.

C. Acrylic-Based Finish Coatings: Factory-mixed, acrylic-emulsion coating systems formulated with colorfast mineral pigments and fine aggregates; for use over cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**California Stucco Products Corp.**]
   b. [**Dryvit Systems, Inc.**]
   c. [**El Rey Stucco Solutions; a Parex USA, Inc. brand**]
   d. [**Finestone, a Sika brand**]
   e. [**Master Wall Inc.**]
   f. [**Omega Products International, Inc.**]
   g. [**Senergy; a SIKA brand**]
   h. [**Sto Corp.**]
   i. [**Stuc-O-Flex International, Inc.**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**California Stucco Products Corp.**]
    b. [**Dryvit Systems, Inc.**]
    c. [**El Rey Stucco Solutions; a Parex USA, Inc. brand**]
    d. [**Finestone, a Sika brand**]
    e. [**Master Wall Inc.**]
    f. [**Omega Products International, Inc.**]
    g. [**Senergy; a SIKA brand**]
    h. [**Sto Corp.**]
    i. [**Stuc-O-Flex International, Inc.**]
    j. <**Insert manufacturer's name**>

3. Color: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.
4. Texture: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert texture**>.
5. Source Limitations: Obtain acrylic-based finish coating from single source from single manufacturer.

2.6 PLASTER MATERIALS

A. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**].

1. Color for Finish Coats: [**White**][**Gray**].

B. Masonry Cement: ASTM C91/C91M, Type N.

1. Color for Finish Coats: [**White**][**Gray**].

C. Plastic Cement: ASTM C1328/C1328M.

D. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color [**to match Architect's sample**]<**Insert requirements**>.

E. Lime: ASTM C206, Type S; or ASTM C207, Type S.

F. Sand Aggregate: ASTM C897.

1. Color for Job-Mixed Finish Coats: [**White**][**In color matching Architect's sample**].

G. Perlite Aggregate: ASTM C35.

H. Exposed Aggregates for Finish Coats: [**For marblecrete finish, clean, sound, crushed marble matching color and size gradation of Architect's sample**]<**Insert requirements**>.

2.7 MISCELLANEOUS MATERIALS

A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, **1/2 inch (13 mm)** long, free of contaminants, manufactured for use in cement plaster.

C. Bonding Compound: ASTM C932.

D. Fasteners for Attaching Metal Lath to Substrates: ASTM C1063.

E. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than **0.0475-inch (1.21-mm)** diameter unless otherwise indicated.

F. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

G. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Reject plaster materials that are wet or moisture damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

B. Prepare smooth, solid substrates for plaster in accordance with ASTM C926.

3.3 INSTALLATION, GENERAL

A. Fire-Resistance-Rated Assemblies: Install components in accordance with requirements for design designations from listing organization and publication indicated on Drawings.

B. Sound-Attenuation Blankets: Where indicated on Drawings, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.

C. Acoustical Sealant: Where indicated on Drawings, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

3.4 INSTALLATION OF METAL LATH

A. Metal Lath: Install in accordance with ASTM C1063.

1. Partition Framing and Vertical Furring: Install [**flat diamond-mesh**][**welded-wire**][**woven-wire**] lath.
2. Flat-Ceiling and Horizontal Framing: Install [**flat diamond-mesh**][**3/8-inch (10-mm) rib**][**welded-wire**][**woven-wire**] lath.
3. Curved-Ceiling Framing: Install [**flat diamond-mesh**][**welded-wire**][**woven-wire**] lath.
4. On Solid Surfaces, Not Otherwise Furred: Install [**self-furring diamond-mesh**][**welded-wire**][**woven-wire**] lath.

3.5 INSTALLATION OF ACCESSORIES

A. Install in accordance with ASTM C1063 and at locations indicated on Drawings.

B. Reinforcement for External (Outside) Corners:

1. Install [**lath-type, external-corner reinforcement**][**cornerbead**] at exterior locations.
2. Install cornerbead at interior locations.

C. Control Joints: Locate as approved by Architect for visual effect and as follows:

1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:

   a. Vertical Surfaces: **144 sq. ft. (13.4 sq. m)**.
   b. Horizontal and Other Nonvertical Surfaces: **100 sq. ft. (9.3 sq. m)**.

2. At distances between control joints of not greater than **18 ft. (5.5 m)** o.c.
3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
4. Where control joints occur in surface of construction directly behind plaster.
5. Where plastered ceiling framing or furring changes direction.
6. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

D. Expansion Joints: Locate where expansion joints occur in supporting construction.

3.6 APPLICATION OF BASE-COAT CEMENT PLASTER

A. General: Comply with ASTM C926.

1. Install so that finished plaster surfaces will not deviate more than plus or minus **1/4 inch in 10 ft. (6 mm in 3 m)** from a true plane when measured by a **10-ft. (3-m)** straightedge placed on surface.
2. Install so finished plaster surfaces will be flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets.

B. Bonding Compound: Apply on [**unit masonry**][**and**][**concrete**] substrates for direct application of plaster.

C. Wall/Vertical Base Coats:

1. Three-Coat Plasterwork Over Metal Lath: Install base-coat mixes for use over metal lath to produce scratch and brown coats having **3/4-inch (19-mm)** total thickness.
2. Two-Coat Plasterwork Over Solid Plaster Bases: Install base-coat mix for use over solid plaster bases in [**3/8-inch (10-mm) thickness on masonry**][**1/4-inch (6-mm) thickness on concrete**].

D. Ceiling/Horizontal Base Coats:

1. Three-Coat Plasterwork Over Metal Lath: Install base-coat mixes for use over metal lath to produce scratch and brown coats with [**1/2-inch (13-mm) total thickness**][**3/4-inch (19-mm) total thickness for metal lath on concrete**].
2. Two-Coat Plasterwork Over Solid Plaster Bases: Install base-coat mix for use over solid plaster bases in **1/4-inch (6-mm)** thickness on concrete.

3.7 APPLICATION OF CEMENT PLASTER FINISH COATS

A. General: Comply with ASTM C926.

1. Do not deviate more than plus or minus **1/4 inch in 10 ft. (6 mm in 3 m)** from a true plane in finished plaster surfaces when measured by a **10-ft. (3-m)** straightedge placed on surface.
2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, groove finish coat at junctures with metal.
3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.

B. Plaster Finish Coats: Apply to provide [**float**][**dash**][**scraped trowel-textured**][**skip trowel-textured**][**brocade (knock-down dash)**][**trowel sweep**][**combed**][**sacked (California mission)**][**English**][**marblecrete**]<**Insert requirements**> finish to match Architect's sample.

C. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, in accordance with manufacturer's written instructions.

D. Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.

E. Concealed Interior Plasterwork:

1. Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
2. Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.
3. Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.

3.8 REPAIR

A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.9 CLEANING

A. Remove temporary protection and enclosure of other work after plastering is complete.

B. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.

C. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 24 00 00

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Task	Specification	Specification Description
09 24 13 00	09 23 00 00	Gypsum Plastering
09 24 13 00	09 24 00 00	Cement Plastering
09 24 23 00	09 24 00 00	Cement Plastering
09 24 33 00	09 24 00 00	Cement Plastering
09 28 13 00	09 29 00 00	Gypsum Board
09 28 13 00	09 01 30 91	Ceramic Tiling

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SECTION 09 29 00 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board.
3. Tile backing panels.
4. Texture finish.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior applications.
2. Section 079219 "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
3. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for steel shaft wall framing, gypsum shaft liners, and other components of shaft wall assemblies.
4. Section 092216 "Non-Structural Metal Framing" for nonstructural steel framing and suspension systems that support gypsum board panels.
5. Section 092613 "Gypsum Veneer Plastering" for gypsum base for veneer plaster and for other components of gypsum-veneer-plaster finishes.
6. Section 093013 "Ceramic Tiling" for tile backing panels installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Locations and installation of control and expansion joints, including plans, elevations, sections, and attachment details.

C. Samples for Initial Selection:

1. Trim Accessories: For [**aluminum trim**][**and**][**base-of-wall PVC moisture-barrier trim**]<**Insert requirements**> .
2. Texture Finish: For each type required.

D. Samples for Verification: Actual sample of finished products for the following:

1. Trim Accessories: Actual sample of finished products for each profile of [**aluminum trim**][**and**][**base-of-wall PVC moisture-barrier trim**]<**Insert requirements**> .

   a. Size: Full size profile, [**12 inches (305 mm)**]<**Insert dimension**> long.

2. Texture Finish: [**Manufacturer's standard size**]<**Insert requirements**> for each texture finish required and on same backing indicated for Work.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
3. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.

1.3 MOCKUPS

A. Build mockups of at least [**100 sq. ft.** (9 sq. m)]<**Insert dimension**> in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for the following:

    a. Each level of interior gypsum board finish required for use in exposed locations.
    b. Each texture finish required.

2. Apply or install final decoration required, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of gypsum board and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings in accordance with ASTM E119; tested by a qualified testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings in accordance with ASTM E90 and classified in accordance with ASTM E413; tested by a qualified testing agency.

C. Verify ceiling and wall materials comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Verify ceiling and wall materials comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

2.3 GYPSUM BOARD, GENERAL

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert number**> percent.

B. Product Data: Verify materials were manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

C. Regional Materials: Verify materials were manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.

D. Size: Provide panel products in maximum lengths and widths available that will minimize joints in each area and that correspond with support system specified or indicated on Drawings.

2.4 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**USG Corporation**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**USG Corporation**]
g. <**Insert manufacturer's name**>

3. Thickness: [**As indicated on Drawings**][**1/4 inch (6.4 mm)**][**3/8 inch (9.5 mm)**][**1/2 inch (12.7 mm)**] .
4. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**]<**Insert requirements**> .

B. Lightweight Gypsum Wallboard: ASTM C1396/C1396M; manufactured to be lighter in weight and have greater sag resistance than traditional gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]
h. <**Insert manufacturer's name**>

3. Thickness: [**As indicated on Drawings**][**1/2 inch (12.7 mm)**] .
4. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**]<**Insert requirements**> .

C. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**PABCO Gypsum**]
   f. [**Panel Rey**]
   g. [**USG Corporation**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**PABCO Gypsum**]
   f. [**Panel Rey**]
   g. [**USG Corporation**]
   h. <**Insert manufacturer's name**>

3. Thickness: [**As indicated on Drawings**][**5/8 inch (15.9 mm)**][**3/4 inch (19.1 mm)**] .
4. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**]<**Insert requirements**> .

D. Lightweight Gypsum Board, Type X: ASTM C1396/C1396M; manufactured to be lighter in weight than traditional Type X gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**USG Corporation**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**USG Corporation**]
f. <**Insert manufacturer's name**>

3. Thickness: [**As indicated on Drawings**][**5/8 inch (15.9 mm)**] .
4. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**]<**Insert requirements**> .

E. Gypsum Board, Type C: ASTM C1396/C1396M; manufactured to have increased fire-resistive capability.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]
h. <**Insert manufacturer's name**>

3. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
5. Long Edges: Tapered.

F. Lightweight Gypsum Board, Type C: ASTM C1396/C1396M; manufactured to have increased fire-resistive capability and to be lighter in weight than traditional gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]

c. [**USG Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
c. [**USG Corporation**]
d. <**Insert manufacturer's name**>

3. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
4. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**]<**Insert requirements**> .

G. Flexible Gypsum Board: ASTM C1396/C1396M; manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**PABCO Gypsum**]
c. [**Panel Rey**]
d. [**USG Corporation**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. [**PABCO Gypsum**]
c. [**Panel Rey**]
d. [**USG Corporation**]
e. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/4 inch (6.4 mm); regular type**][**3/8 inch (9.5 mm); regular type**][**5/16 inch (7.9 mm); Type C as required by fire-resistance-rated assembly on Drawings; with ASTM D3273 mold-resistance score of 10 rated in accordance with ASTM D3274**]<**Insert requirements**> .
4. Long Edges: Tapered.

H. Gypsum Ceiling Board: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]

d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**Panel Rey**]
g. [**USG Corporation**]
h. <**Insert manufacturer's name**>

3. Thickness: [**As indicated on Drawings**][**1/2 inch (12.7 mm)**] .
4. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**]<**Insert requirements**> .

I. Foil-Backed Gypsum Board: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
b. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**]<**Insert requirements**> .
4. Long Edges: [**Tapered**]<**Insert requirements**> .

J. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M, tested in accordance with ASTM C1629/C1629M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]

d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**USG Corporation**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**USG Corporation**]
g. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**5/8 inch (15.9 mm), Type X**]<**Insert requirements**> .
4. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
5. Indentation: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
6. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
7. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
8. Long Edges: [**Tapered**]<**Insert requirements**> .

K. Impact-Resistant Gypsum Board: ASTM C1396/C1396M or ASTM C1658/C1658M, tested in accordance with ASTM C1629/C1629M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**USG Corporation**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Georgia-Pacific Gypsum LLC**]
d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
e. [**PABCO Gypsum**]
f. [**USG Corporation**]
g. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**5/8 inch (15.9 mm), Type X**]<**Insert requirements**> .
4. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**]

requirements.

5. Indentation: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
6. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
7. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements in accordance with test in Annex A1.
8. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
9. Long Edges: [**Tapered**]<**Insert requirements**> .

L. Mold-Resistant Gypsum Board: ASTM C1396/C1396M; manufactured with moisture- and mold-resistant core and paper surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**PABCO Gypsum**]
   f. [**Panel Rey**]
   g. [**USG Corporation**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**PABCO Gypsum**]
   f. [**Panel Rey**]
   g. [**USG Corporation**]
   h. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**]<**Insert requirements**> .
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
5. Long Edges: [**Square**][**Tapered**]<**Insert requirements**> .

M. Lightweight Mold-Resistant Gypsum Board: ASTM C1396/C1396M; manufactured with moisture- and mold-resistant core and paper surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**USG Corporation**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**USG Corporation**]
    b. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**]<**Insert requirements**> .
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
5. Long Edges: [**Tapered**][**Tapered and featured (rounded or beveled) for prefilling**]<**Insert requirements**> .

N. Glass-Mat Interior Gypsum Board: ASTM C1658/C1658M; manufactured with fiberglass mat laminated to both sides and designed for interior use.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**PABCO Gypsum**]
    e. [**Panel Rey**]
    f. [**USG Corporation**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**PABCO Gypsum**]
    e. [**Panel Rey**]
    f. [**USG Corporation**]
    g. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**]<**Insert requirements**> .
4. Abuse and Impact Resistance:

    a. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
    b. Indentation: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
    c. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements.
    d. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds [**Level 1**][**Level 2**][**Level 3**] requirements in accordance with test in Annex A1.

5. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
6. Long Edges: Tapered.

O. Acoustically Enhanced Gypsum Board: ASTM C1766; multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    c. [**PABCO Gypsum**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    c. [**PABCO Gypsum**]
    d. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**5/8 inch (15.9 mm), Type X**]<**Insert requirements**> .
4. Long Edges: Tapered.

P. Trim for Interior Gypsum Board: ASTM C1047.

1. Material: [**Galvanized-steel sheet or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet**][**Galvanized-steel sheet or aluminum-coated steel sheet or rolled zinc**][**Plastic**][**Paper-faced galvanized-steel sheet**][**PVC**]<**Insert material**> .
2. Shapes:

    a. Cornerbead.
    b. Bullnose bead.
    c. LC-Bead: J-shaped; exposed long flange receives joint compound.
    d. L-Bead: L-shaped; exposed long flange receives joint compound.
    e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    f. Curved-Edge Cornerbead: With notched or flexible flanges.
    g. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

Q. Base-of-Wall PVC Moisture-Barrier Trim: Proprietary extruded shapes that lifts finish panels above the floor surface to prevent moisture damage.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Waterguard**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Waterguard**]
    b. <**Insert manufacturer's name**>

3. Height: [**1/2 inch (12.7 mm)**][**1-3/4 inches (44 mm)**][**3-1/2 inches (89 mm)**] .
4. Fire-Resistance-Rated Assemblies: Comply with requirements of assembly indicated on Drawings.

R. Aluminum Trim: Extruded accessories of profiles and dimensions indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Brand X Metals, Inc**]
    b. [**Flannery, Inc.**]
    c. [**Fry Reglet Corporation**]
    d. [**Gordon Inc.**]
    e. [**Pittcon Industries**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Brand X Metals, Inc**]
    b. [**Flannery, Inc.**]
    c. [**Fry Reglet Corporation**]
    d. [**Gordon Inc.**]
    e. [**Pittcon Industries**]
    f. <**Insert manufacturer's name**>

3. Product Standard: Alloy and temper with not less than the strength and durability properties of **ASTM B221 (ASTM B221M)**, Alloy 6063-T5.
4. Finish: [**Corrosion-resistant primer compatible with joint compound and finish materials specified**]<**Insert finish**> .

S. Joint Treatment Materials for Interior Gypsum Board: Comply with ASTM C475/C475M requirements.

1. Joint Tape: Paper.
2. Joint Compound: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

    a. Mold-Resistant Joint Compound: Use mold-resistant formulations with mold-resistant gypsum board products.
    b. Prefilling: At open joints [**, rounded or beveled panel edges,**] and damaged surface areas, use setting-type taping compound.
    c. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use [**setting-type taping**][**drying-type, all-purpose**] compound.
    d. Fill Coat: For second coat, use [**setting-type, sandable topping**][**drying-type, all-purpose**] compound.
    e. Finish Coat: For third coat, use [**setting-type, sandable topping**][**drying-type, all-**

purpose] compound.

f. Skim Coat: For final coat of Level 5 finish, use [**setting-type, sandable topping compound**][**drying-type, all-purpose compound**][**high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish**] .

2.5 EXTERIOR GYPSUM BOARD

A. Exterior Gypsum Soffit Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**PABCO Gypsum**]
   f. [**Panel Rey**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Gypsum**]
   b. [**CertainTeed; SAINT-GOBAIN**]
   c. [**Georgia-Pacific Gypsum LLC**]
   d. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
   e. [**PABCO Gypsum**]
   f. [**Panel Rey**]
   g. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), Type C as required by fire-resistance-rated assembly indicated on Drawings**]<**Insert requirements**> .

B. Trim for Exterior Gypsum Board: ASTM C1047.

1. Material: [**Hot-dip galvanized-steel sheet, plastic, or rolled zinc**]<**Insert material**> .
2. Shapes:

   a. Cornerbead.
   b. LC-Bead: J-shaped; exposed long flange receives joint compound.
   c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Joint Treatment Materials for Exterior Gypsum Board: Comply with ASTM C475/C475M requirements.

1. Joint Tape: Paper.
2. Joint Compound: Use setting-type taping compound and setting-type, sandable topping

compound.

2.6 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Gypsum Panel: ASTM C1658/C1658M, with fiberglass mat partially or completely embedded into the core.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**PABCO Gypsum**]
e. [**Panel Rey**]
f. [**USG Corporation**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**PABCO Gypsum**]
e. [**Panel Rey**]
f. [**USG Corporation**]
g. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm), regular type**][**1/2 inch (12.7 mm), Type C**][**5/8 inch (15.9 mm), Type X**][**5/8 inch (15.9 mm), abuse resistant**] .
4. Long Edges: Tapered.
5. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

B. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: ASTM C1178/C1178M, with a water-resistant coating on one surface, and manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**Georgia-Pacific Gypsum LLC**]
c. [**USG Corporation**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]

b. [**Georgia-Pacific Gypsum LLC**]
c. [**USG Corporation**]
d. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm)**, **regular type**][**5/8 inch (15.9 mm)**, **Type X**] .
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

C. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**Panel Rey**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Gypsum**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
d. [**Panel Rey**]
e. <**Insert manufacturer's name**>

3. Core: [**As indicated on Drawings**][**1/2 inch (12.7 mm)**, **regular type**][**5/8 inch (15.9 mm)**, **Type X**]<**Insert requirements**> .

D. Joint Treatment Materials for Tile Backing Panels: Comply with ASTM C475/C475M requirements.

1. Mold-Resistant Joint Compound: Use mold-resistant formulations with mold-resistant panel products.
2. Joint Tape: As recommended in writing by panel manufacturer.
3. Joint Compound for Tile Backing Panels:

a. Glass-Mat, Water-Resistant Gypsum Panel: As recommended in writing by panel manufacturer.
b. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: As recommended in writing by panel manufacturer.
c. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.7 Gypsum Board, Type C

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Gypsum**]

2. [**CertainTeed; SAINT-GOBAIN**]
3. [**Georgia-Pacific Gypsum LLC**]
4. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
5. [**PABCO Gypsum**]
6. [**Panel Rey**]
7. [**USG Corporation**]
8. <**Insert manufacturer's name**>

2.8 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended in writing by manufacturer for directly adhering gypsum panels to continuous substrate.

1. Verify adhesives have a VOC content of [**50**]<**Insert number**> g/L or less.

C. Steel Drill Screws: ASTM C1002 unless otherwise specified or indicated on Drawings.

1. Use screws complying with ASTM C954 for fastening panels to steel members from **0.033 to 0.112 inch (0.84 to 2.84 mm)** thick.

D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers as follows:

1. Non-Fire-Resistance-Rated Assemblies: [**Glass**][**or**][**slag or rock wool**] .
2. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert number**> percent.

E. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

1. Product Data: Verify architectural sealant has a VOC content of 250 g/L or less.

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

G. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

2.9 Paperless Wallboard

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.10 TEXTURE FINISH

A. Primer: As recommended in writing by texture finish manufacturer.

B. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indexes of not more than 25 when tested in accordance with ASTM E84.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
    b. [**USG Corporation**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
    b. [**USG Corporation**]
    c. <**Insert manufacturer's name**>

3. Texture: [**Fine**][**Medium**][**Coarse**] .

C. Aggregate Job-Mixed Finish: Water-based, drying-type texture finish for spray application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
    c. [**USG Corporation**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
    c. [**USG Corporation**]
    d. <**Insert manufacturer's name**>

3. Texture: [**Light spatter**][**Spatter knock-down**]<**Insert texture**> .

D. Non-Aggregate Premixed Finish: Vinyl texture finish for spray application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
    c. [**USG Corporation**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**CertainTeed; SAINT-GOBAIN**]
b. [**ProForm Finishing Products, LLC provided by National Gypsum Company**]
c. [**USG Corporation**]
d. <**Insert manufacturer's name**>

3. Texture: [**Orange peel**][**Spatter**][**Spatter knock-down**]<**Insert texture**> .

E. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**International Cellulose Corp.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**International Cellulose Corp.**]
b. <**Insert manufacturer's name**>

3. Application Thickness: [**1/2 inch (12.7 mm)**]<**Insert dimension**> .
4. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**5**]<**Insert value**> or less.
b. Smoke-Developed Index: [**5**]<**Insert value**> or less.

5. NRC: [**0.65**]<**Insert NRC**> in accordance with ASTM C423.

2.11 Tile Backing Panels: Water-Resistant Fiber-Reinforced Gypsum Backing Board

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. <**Insert manufacturer's name**>

2.12 Glass-Mat, Water-Resistant Backing Board

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CertainTeed; SAINT-GOBAIN**]
2. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
3. [**USG Corporation**]
4. <**Insert manufacturer's name**>

2.13 Gypsum Board, Type X

A. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Gypsum**]
2. [**CertainTeed; SAINT-GOBAIN**]
3. [**Georgia-Pacific Gypsum LLC**]
4. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
5. [**PABCO Gypsum**]
6. [**Panel Rey**]
7. [**USG Corporation**]
8. <**Insert manufacturer's name**>

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF GYPSUM BOARD, GENERAL

A. Comply with ASTM C840 requirements.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than **1/16 inch (1.6 mm)** of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form expansion (control) joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than **8 sq. ft. (0.7 sq. m)** in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow **1/4- to 3/8-inch- (6.4-**

to 9.5-mm-) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 requirements and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

K. Install sound-attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated on Drawings.
2. On partitions/walls, apply gypsum panels [**vertically (parallel to framing)**][**horizontally (perpendicular to framing)**] unless otherwise specified or indicated on Drawings or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    b. At stairwells and other high walls, install panels horizontally unless otherwise indicated on Drawings or required by fire-resistance-rated assembly.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

B. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (406 mm) minimum, from parallel base-layer joints, unless otherwise indicated on Drawings or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over studs or furring members and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated on Drawings or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers [**and face layers separately to supports with screws**][**with screws; fasten face layers with adhesive and supplementary fasteners**] .

C. Application of Laminating Adhesive to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

D. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus **12-inch- (305-mm-)** long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws **16 inches (406 mm)** o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced **12 inches (305 mm)** o.c.

E. Trim for Interior Gypsum Board: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim in accordance with manufacturer's written instructions.

1. Cornerbead: Install at outside corners [**unless otherwise specified or indicated on Drawings**] .
2. Bullnose Bead: Install [**at outside corners**][**where indicated on Drawings**]<**Insert requirements**> .
3. LC-Bead: Install [**at exposed panel edges**]<**Insert requirements**> .
4. L-Bead: Install [**where indicated on Drawings**]<**Insert requirements**> .
5. U-Bead: Install [**at exposed panel edges**][**where indicated on Drawings**]<**Insert requirements**> .
6. Curved-Edge Cornerbead: Install at curved openings.
7. Expansion (Control) Joint: Install control joints [**at locations indicated on Drawings**][**in accordance with ASTM C840 and in specific locations approved by Architect for visual effect**]<**Insert requirements**> .

F. Base-of-Wall PVC Moisture Barrier Trim: Install at base of wall [**unless otherwise specified or indicated on Drawings**] .

G. Aluminum Trim: Install in locations [**indicated on Drawings**]<**Insert requirements**> .

H. Joint Treatment Materials for Interior Gypsum Board: Treat joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare panel surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

1. Prefill open joints [**, rounded or beveled edges,**] and damaged surface areas.
2. Apply joint tape over panel joints, except for trim products specifically indicated as not intended to receive tape.

I. Finish interior gypsum board panels to comply with levels indicated below and in accordance with ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated on Drawings.
2. Level 2: [**Panels that are substrate for tile**][**Panels that are substrate for acoustical**

tile][**Where indicated on Drawings**]<**Insert locations**> .

3. Level 3: [**Where indicated on Drawings**]<**Insert locations**> .

    a. Primer and its application to surfaces are specified in [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

4. Level 4: [**At panel surfaces that will be exposed to view unless otherwise indicated**]<**Insert locations**> .

    a. Primer and its application to surfaces are specified in [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

5. Level 5: [**Where indicated on Drawings**]<**Insert locations**> .

    a. Primer and its application to surfaces are specified in [**Section 099123 "Interior Painting."**][**Section 099124 "Interior Painting (MPI Standards)."**]

3.4 INSTALLATION OF EXTERIOR GYPSUM BOARD

A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with **1/4-inch (6.4-mm)** open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

B. Trim for Exterior Gypsum Board: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use [**at exposed panel edges**]<**Insert requirements**> .
3. Expansion (Control) Joint: Install control joints [**at locations indicated on Drawings**][**in accordance with ASTM C840 and in specific locations approved by Architect for visual effect**]<**Insert requirements**> .

C. Finish exterior gypsum board in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Gypsum Panel: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with **1/4-inch (6.4-mm)** gap where panels abut other construction or penetrations.

B. Coated Glass-Mat, Water-Resistant Gypsum Backing Panel: Comply with manufacturer's written installation instructions and install at [**showers, tubs, and where indicated on Drawings**][**locations indicated to receive tile**] . Install with **1/4-inch (6.4-mm)** gap where panels abut other construction or penetrations.

C. Water-Resistant Gypsum Backing Board: Install where indicated with **1/4-inch (6.4-mm)** gap where panels abut other construction or penetrations.

D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

E. Finish tile backing panels in accordance with manufacturer's written instructions.

3.6 APPLICATION OF TEXTURE FINISH

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finish. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture [**matching approved mockup and**] free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finish from contacting surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finish contacts these surfaces, immediately remove droppings and overspray to prevent damage in accordance with texture-finish manufacturer's written instructions.

3.7 PROTECTION

A. Protect adjacent surfaces from joint compound and promptly remove from floors and other non-gypsum board surfaces. Repair surfaces stained, marred, or otherwise damaged during gypsum board installation and finishing.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that have gotten wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00 00

Task	Specification	Specification Description
09 29 10 00	01 22 00 00	No Specification Required
09 29 10 00	09 29 00 00	Gypsum Board
09 29 82 00	09 29 00 00	Gypsum Board

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SECTION 09 51 13 00 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical panels.
2. Exposed metal suspension system.
3. Metal edge moldings and trim.

B. Related Requirements:

1. Section 095123 "Acoustical Tile Ceilings" for ceilings consisting of mineral-base acoustical tiles used with fully concealed suspension systems, stapling, or adhesive bonding.
2. Section 095133 "Acoustical Metal Pan Ceilings" for ceilings consisting of metal-pan units with exposed and concealed suspension systems.

C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at Project site**][**by web conference**]<**Insert location**> .

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** in size.

C. Samples for Initial Selection: For components with factory-applied finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Panels: Set of [**full-size**][**6-inch- (150-mm-) square**]<**Insert size**> Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of [**6-inch- (150-mm-)**]<**Insert dimension**> long Samples of each type, finish, and color.
3. Clips: Full-size [**hold-down**][**impact**][**and**][**seismic**] clips.

E. Delegated Design Submittals: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer

recycled content and cost.

3. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
4. Environmental Product Declaration (EPD): For each product.
5. Health Product Declaration (HPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Health Product Declaration (HPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.
13. Health Product Declaration (HPD): For each product.
14. Health Product Declaration (HPD): Provide HPD.
15. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

    a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
    b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
    c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

16. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
17. Laboratory Test Reports: For ceiling products, indicating compliance with the VOC emissions evaluation.
18. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

    a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures.
    b. Diffusers.
    c. Grilles.
    d. Speakers.
    e. Sprinklers.
    f. Access panels.

g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: [**1/4 inch = 1 ft. (1:48)**][**1/8 inch = 1 ft. (1:96)**][**1:50**][**1:100**]<**Insert scale**> .

B. Product Test Reports: For each acoustical panel ceiling, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**] .

C. Evaluation Reports: For each acoustical panel ceiling suspension system [**and anchor and fastener type**] , from ICC-ES.

D. Field Quality Control Reports: For specified tests and inspections.

E. Qualification Statements: For testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials [**, from the same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Panels: Full-size panels equal to [**2**]<**Insert number**> percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to [**2**]<**Insert number**> percent of quantity installed.
3. Hold-Down Clips: Equal to [**2**]<**Insert number**> percent of quantity installed.
4. Impact Clips: Equal to [**2**]<**Insert number**> percent of quantity installed.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical ceiling area as indicated on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Ceiling System: Obtain each type of acoustical panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

B. Seismic Performance: Suspended ceilings to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**> .

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class [**A**][**B**][**C**] in accordance with ASTM E1264.
2. Smoke-Developed Index: [**50**][**450**]<**Insert value**> or less.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

E. Verify ceiling products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Verify ceiling products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

2.3 ACOUSTICAL PANEL CEILINGS

A. Acoustical Panels : Provide manufacturer's standard panels in accordance with ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**American Gypsum**]
    b. [**Armstrong World Industries**]
    c. [**Cardinal Acoustics, Inc.**]
    d. [**CertainTeed; SAINT-GOBAIN**]
    e. [**Rockfon; ROCKWOOL International**]
    f. [**USG Corporation**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Gypsum**]
    b. [**Armstrong World Industries**]
    c. [**Cardinal Acoustics, Inc.**]
    d. [**CertainTeed; SAINT-GOBAIN**]
    e. [**Rockfon; ROCKWOOL International**]
    f. [**USG Corporation**]
    g. <**Insert manufacturer's name**>

3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert number**> percent.
4. Classification: Provide [**fire-resistance-rated**] panels as follows:

    a. Type and Form, Type III: Mineral base with painted finish; [**Form 1, nodular**][**Form 2, water felted**][**Form 4, cast or molded**] .
    b. Type and Form, Type IV Form 1: Mineral base with membrane-faced overlay; Form 1, nodular; with [**glass-fiber cloth**][**washable vinyl-film**] overlay.
    c. Type and Form, Type IV Form 2: Mineral base with membrane-faced overlay; Form 2, water felted; with [**vinyl overlay on face**][**vinyl overlay on face and back**][**vinyl overlay on face, back, and sealed edges**][**fiberglass-fabric overlay on face**] .
    d. Type and Form, Type XII: Glass-fiber base with membrane-faced overlay; [**Form 1, plastic**][**Form 2, cloth**][**Form 3, other**] . Binder may not contain urea formaldehyde.
    e. Type and Form, Type XX: High-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.
    f. Type and Form: <**Insert type and form**> .
    g. Pattern: [**C (perforated, small holes)**][**CD (perforated, small holes and fissured)**][**CE (perforated, small holes and lightly textured)**][**D (fissured)**][**E (lightly textured)**][**F (heavily textured)**][**G (smooth)**][**GH (smooth and printed)**][**I (embossed)**][**J (embossed-in-register)**][**K (surface scored)**][**Z (other patterns as described)**][**and**][**as indicated by manufacturer's designation**]<**Insert pattern**> .

5. Color: [**White**][**As selected from manufacturer's full range**][**Match Architect's sample**][**As indicated by manufacturer's designation**][**As indicated on Drawings**][**As indicated in a schedule**]<**Insert color**> .
6. Light Reflectance (LR): Not less than [**LR indicated in a schedule**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**]<**Insert LR**> .
7. Ceiling Attenuation Class (CAC): Not less than [**CAC indicated in a schedule**][**20**][**25**][**30**][**35**][**40**]<**Insert CAC**> .
8. Noise Reduction Coefficient (NRC): Not less than [**NRC indicated in a schedule**][**0.40**][**0.50**][**0.55**][**0.60**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**][**0.95**][**1.00**]<**Insert NRC**> .

9. Articulation Class (AC): Not less than [**AC indicated in a schedule**][**170**][**180**][**190**][**200**][**210**]<**Insert AC**> .
10. Edge/Joint Detail: [**Square**][**Reveal sized to fit flange of exposed suspension-system members**][**Flush reveal sized to fit flange of exposed suspension-system members**][**Beveled, kerfed, and rabbeted long edges and square, butt-on short edges**][**As indicated by manufacturer's designation**]<**Insert requirement**> .
11. Thickness: [**5/8 inch (15 mm)**][**3/4 inch (19 mm)**][**7/8 inch (22 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**As indicated on Drawings**][**As indicated in a schedule**]<**Insert dimension**> .
12. Modular Size: [**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1220 mm)**][**24 by 72 inches (610 by 1830 mm)**][**24 by 96 inches (610 by 2440 mm)**][**48 by 48 inches (1220 by 1220 mm)**][**600 by 600 mm**][**600 by 1200 mm**][**As indicated on Drawings**][**As indicated in a schedule**]<**Insert size**> .
13. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested in accordance with ASTM D3273, ASTM D3274, or ASTM G21 and evaluated in accordance with ASTM D3274 or ASTM G21.

B. Exposed Metal Suspension System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Armstrong World Industries**]
    b. [**Cardinal Acoustics, Inc.**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Cipriani USA**]
    e. [**Rockfon; ROCKWOOL International**]
    f. [**USG Corporation**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Armstrong World Industries**]
    b. [**Cardinal Acoustics, Inc.**]
    c. [**CertainTeed; SAINT-GOBAIN**]
    d. [**Cipriani USA**]
    e. [**Rockfon; ROCKWOOL International**]
    f. [**USG Corporation**]
    g. <**Insert manufacturer's name**>

3. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories in accordance with ASTM C635/C635M and designated by type, structural classification, and finish indicated.

    a. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" in accordance with ASTM C635/C635M.

4. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; with prefinished **15/16-inch- (24-mm-)** wide metal caps on flanges.

a. Fire Rating: [**As indicated on Drawings**]<**Insert fire rating**> .
b. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
c. End Condition of Cross Runners: [**Override (stepped)**][**or**][**butt-edge**] type.
d. Face Design: Flat, flush.
e. Cap Material: [**Cold-rolled steel**][**or**][**aluminum**] .
f. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Plated with metallic finish as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**][**Natural finish for aluminum**] .

5. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; with prefinished **9/16-inch- (15-mm-)** wide metal caps on flanges.

a. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
b. End Condition of Cross Runners: [**Override (stepped)**][**or**][**butt-edge**] type.
c. Face Design: [**Flat, flush**][**Flanges formed with an integral center reveal**] .
d. Cap Material: [**Cold-rolled steel**][**or**][**aluminum**] .
e. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Plated with metallic finish as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**][**Natural finish for aluminum**] .

6. Narrow-Face, Steel-Capped, Double-Web, Fire-Rated Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; with prefinished, cold-rolled, **9/16-inch- (15-mm-)** wide metal caps on flanges.

a. Structural Classification: Intermediate-duty system.
b. Face Design: Flat, flush.
c. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Plated with metallic finish as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**] .

7. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; to produce structural members with **9/16-inch- (15-mm-)** wide faces.

a. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
b. Face Design: [**With 1/8-inch- (3-mm-) wide, slotted, box-shaped flange**][**With 1/4-inch- (6-mm-) wide, slotted, box-shaped flange**][**Flanges formed in stepped design with a center protrusion projecting 19/64 inch (7.54 mm) below flange surfaces supporting panel faces and forming 3/16-inch- (4.76-mm-) wide reveals between edges of protrusion and those of panels**] .
c. Face Finish: Painted [**white**][**in color as selected from manufacturer's full range**][**to match color indicated by manufacturer's designation**][**to match color of acoustical unit**] .
d. Reveal Finish: Painted [**to match flange color**][**white**][**black**][**in color other than flange color as selected from manufacturer's full range of contrasting reveal colors**] .

8. Wide-Face, Aluminum-Capped, Double-Web, Hot-Dip Galvanized, G60 (Z180), Steel Suspension

System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized, **G60 (Z180)** coating designation; with prefinished, **15/16-inch- (24-mm-)** wide aluminum caps on flanges.

a. Fire Rating: [**As indicated on the Drawings**]<**Insert fire rating**> .
b. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
c. Face Design: Flat, flush.
d. Cap Finish: [**Painted white**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Natural finish**] .

9. Wide-Face, Single-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet electrolytically zinc coated, with prefinished flanges of width indicated.

a. Structural Classification: Heavy-duty system.
b. Face Finish: Painted [**white**][**black**] .

10. Wide-Face, Capped, Double-Web, Stainless Steel Suspension System: Main and cross runners roll formed from Type 304 or 316 stainless steel sheet, with prefinished **15/16-inch- (24-mm-)** wide, stainless steel caps on flanges.

a. Structural Classification: Intermediate-duty system.
b. Face Design: Flat, flush.

11. Narrow-Face, Single-Web, Extruded-Aluminum Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with **9/16-inch- (15-mm-)** wide faces.

a. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
b. Face Design: Screw-slot profile.
c. Face Finish: [**Painted white**][**Satin anodized in accordance with AAMA 611, AA-M12C22A31**] .
d. Reveal Finish: [**Match face finish**][**Painted white**][**Painted black**] .

12. Extra-Wide-Face, Metal Suspension System: Main and cross runners formed from [**extruded aluminum**][**aluminum-capped steel**][**steel-capped steel**]<**Insert description**> to produce structural members with [**1-1/2-inch- (38-mm-)**][**2-inch- (50-mm-)**] wide flanges.

a. Structural Classification: [**Intermediate**][**Heavy**] -duty system.
b. Face Design: Flat, flush.
c. Face Finish: [**Painted white**][**Satin anodized in accordance with AAMA 611, AA-M12C22A31**] .
d. Gasket System: Clean-room type.

C. Metal Edge Moldings and Trim :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Armstrong World Industries**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Cipriani USA**]
d. [**Rockfon; ROCKWOOL International**]
e. [**USG Corporation**]

f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong World Industries**]
b. [**CertainTeed; SAINT-GOBAIN**]
c. [**Cipriani USA**]
d. [**Rockfon; ROCKWOOL International**]
e. [**USG Corporation**]
f. <**Insert manufacturer's name**>

3. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

a. Edge moldings to fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
b. For lay-in panels with reveal edge details, provide [**stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member**]<**Insert description**> .
c. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

4. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
5. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
6. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.4 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. [**Comply with seismic design requirements.**]

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to [**five**]<**Insert safety factor**> times that imposed by ceiling construction, as determined by testing in accordance with ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: [**Cast-in-place**][**Postinstalled expansion**][**Postinstalled bonded**] anchors.
b. Corrosion Protection, Carbon Steel: Components zinc plated in accordance with ASTM B633, Class SC 1 (mild) service condition.
c. Corrosion Protection, Stainless Steel: Components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.
d. Corrosion Protection, Nickel-Copper Alloy: Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application

indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to [**10**]<**Insert safety factor**> times that imposed by ceiling construction, as determined by testing in accordance with ASTM E1190, conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than [**0.106-inch- (2.69-mm-)**][**0.135-inch- (3.5-mm-)**]<**Insert dimension**> diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed with **0.04-inch- (1-mm-)** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

F. Hold-Down Clips: Manufacturer's standard hold-down.

G. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

H. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.

I. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

K. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including [**manufacturer's standard**][**closed-cell PVC**][**neoprene**][**antimicrobial**] gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.5 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation

tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION OF ACOUSTICAL PANEL CEILINGS

A. Install acoustical panel ceilings in accordance with ASTM C636/C636M [**, seismic design requirements,**] and manufacturer's written instructions.

1. Fire-Rated Assembly: Install fire-rated ceiling systems in accordance with tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required [**and, if permitted with fire-resistance-rated ceilings,**] to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Metal Edge Moldings and Trim: Install edge moldings and trim of type indicated at perimeter of acoustical panel ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than **16 inches (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. Arrange directionally patterned acoustical panels as follows:

   a. As indicated on reflected ceiling plans.
   b. Install panels with pattern running in one direction parallel to [**long**][**short**] axis of space.
   c. Install panels in a basket-weave pattern.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Install [**hold-down**][**impact**][**and**][**seismic**] clips in areas indicated; space in accordance with panel manufacturer's written instructions unless otherwise indicated.

   a. Hold-Down Clips: Space [**24 inches (610 mm)**]<**Insert dimension**> o.c. on all cross runners.

7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
8. Protect lighting fixtures and air ducts in accordance with requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of [**1/8 inch in 12 ft. (3 mm in 3.6 m)**]<**Insert dimensions**> , non-cumulative.

B. Metal Edge Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of [**1/8 inch in 12 ft. (3 mm in 3.6 m)**]<**Insert dimensions**> , non-cumulative.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids in accordance with ASCE/SEI 7.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for **200 lbf (890 N)** of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for **440 bf (1957 N)** of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
3. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 13 00

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SECTION 09 51 23 00 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical tiles.
2. Metal suspension system.
3. Metal edge moldings and trim.

B. Related Requirements:

1. Section 095113 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.
2. Section 095133 "Acoustical Metal Pan Ceilings" for ceilings consisting of metal-pan units with exposed and concealed suspension systems.

C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
3. Environmental Product Declaration (EPD): For each product.
4. Health Product Declaration (HPD): For each product.
5. Environmental Product Declaration (EPD): For each product.
6. Health Product Declaration (HPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Environmental Product Declaration (EPD): For each product.
9. Environmental Product Declaration (EPD): For each product.
10. Third-Party Certifications: For each product.
11. Third-Party-Certified Life-Cycle Assessment: For each product.
12. Health Product Declaration (HPD): For each product.
13. Health Product Declaration (HPD): Provide HPD.
14. Health Product Declaration (HPD): Provide documentation confirming product compliance with

one of the following:

a. Inventory or HPD to at least 0.01 percent by weight, with at least 95 percent assessed using GreenScreen Benchmark assessment.
b. Cradle to Cradle v3 certification with minimum Silver level of Material Health.
c. Living Product Challenge certification indicating achievement of Imperative 09, "Transparent Material Health."

15. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
16. Product Data: For adhesives, indicating VOC content.
17. Laboratory Test Reports: For ceiling products, indicating compliance with the VOC emissions evaluation.
18. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

C. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** in size.

D. Samples for Initial Selection: For components with factory-applied finishes.

E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Tiles: Set of full-size Samples of each type, color, pattern, and texture.
2. Concealed Suspension-System Members: [**6-inch- (150-mm-)**]<**Insert dimension**> long Sample of each type.
3. Exposed Moldings and Trim: Set of [**6-inch- (150-mm-)**]<**Insert dimension**> long Samples of each type and color.
4. Seismic Clips: Full size.

F. Delegated Design Submittals: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

a. Lighting fixtures.
b. Diffusers.
c. Grilles.
d. Speakers.
e. Sprinklers.
f. Access panels.
g. Perimeter moldings.
h. <**Insert item**>.

7. Show operation of hinged and sliding components adjacent to acoustical tiles.
8. Minimum Drawing Scale: [**1/4 inch = 1 foot (1:48)**][**1/8 inch = 1 foot (1:96)**][**1:50**][**1:100**]<**Insert scale**>.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical tile ceiling, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Evaluation Reports: For each acoustical tile ceiling suspension system[**and anchor and fastener type**], from ICC-ES.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[**, from the same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: Full-size tiles equal to [**2**]<**Insert number**> percent of quantity installed.
2. Suspension-System Components: Quantity of each concealed grid and exposed component equal to [**2**]<**Insert number**> percent of quantity installed.

1.7 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical ceiling area as indicated on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical tiles, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture,

humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Suspended Acoustical Tile Ceiling System: Obtain each type of acoustical ceiling tile and its suspension system from single source from single manufacturer.

B. Source Limitations for Directly Attached Acoustical Tile Ceiling Tile: Obtain each type of acoustical ceiling tile from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Verify ceiling products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Verify ceiling products comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

D. Seismic Performance: Suspended ceilings to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

E. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class [**A**][**B**][**C**] in accordance with ASTM E1264.
2. Smoke-Developed Index: [**50**][**450**]<**Insert value**> or less.

F. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL TILES

A. Acoustical Tiles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong World Industries, Inc**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Rockfon; ROCKWOOL International**]
    d. [**USG Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Armstrong World Industries, Inc**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Rockfon; ROCKWOOL International**]
    d. [**USG Corporation**]
    e. <**Insert manufacturer's name**>

3. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E1264 classifications as designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
4. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert number**> percent.
5. Classification: Provide[**fire-resistance-rated**] tiles as follows:

    a. Type and Form, Type III: Mineral base with painted finish; [**Form 1, nodular**][**Form 2, water felted**][**Form 4, cast or molded**].
    b. Type and Form: <**Insert type and form**>.
    c. Pattern: [**C (perforated, small holes)**][**CD (perforated, small holes and fissured)**][**CE (perforated, small holes and lightly textured)**][**D (fissured)**][**E (lightly textured)**][**F (heavily textured)**][**G (smooth)**][**I (embossed)**][**J (embossed-in-register)**][**and**][**as indicated by manufacturer's designation**]<**Insert pattern**>.

6. Color: [**White**][**As selected from manufacturer's full range**][**Match Architect's sample**][**As indicated by manufacturer's designation**][**As indicated on Drawings**][**As indicated in a schedule**]<**Insert color**>.
7. Light Reflectance (LR): Not less than [**LR indicated in a schedule**][**0.65**][**0.70**][**0.75**][**0.80**]<**Insert LR**>.
8. Ceiling Attenuation Class (CAC): Not less than [**CAC indicated in a schedule**][**20**][**25**][**30**][**35**][**40**]<**Insert CAC**>.
9. Noise Reduction Coefficient (NRC): Not less than [**NRC indicated in a schedule**][**0.50**][**0.55**][**0.60**][**0.65**][**0.70**]<**Insert NRC**>.
10. Articulation Class (AC): Not less than [**AC indicated in a schedule**][**170**][**180**][**190**][**200**][**210**]<**Insert AC**>.
11. Edge/Joint Detail: [**Square, kerfed, and rabbeted; tongue and grooved; or butt**][**Beveled, kerfed, and rabbeted; tongue and grooved; or butt**][**Beveled, kerfed, and rabbeted long**

edges and square, butt on short edges][**As indicated by manufacturer's designation**]<**Insert requirement**>.

12. Thickness: [**5/8 inch (15 mm)**][**3/4 inch (19 mm)**][**As indicated on Drawings**][**As indicated in a schedule**]<**Insert thickness**>.
13. Modular Size: [**12 by 12 inches (305 by 305 mm)**][**300 by 300 mm**][**As indicated on Drawings**][**As indicated in a schedule**]<**Insert size**>.
14. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested in accordance with ASTM D3273, ASTM D3274, or ASTM G21 and evaluated in accordance with ASTM D3274 or ASTM G21.

2.4 METAL SUSPENSION SYSTEM

A. Concealed or Semi-Exposed Metal Suspension System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Rockfon; ROCKWOOL International**]
    d. [**USG Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Armstrong Ceiling & Wall Solutions**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Rockfon; ROCKWOOL International**]
    d. [**USG Corporation**]
    e. <**Insert manufacturer's name**>

3. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, fully concealed, metal suspension system and accessories of type, structural classification, and finish indicated that complies with applicable requirements in ASTM C635/C635M.

    a. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" in accordance with ASTM C635/C635M.

4. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation.

    a. Fire Rating: [**As indicated on Drawings**]<**Insert fire rating**>.
    b. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
    c. Access: [**Upward**][**Downward**] and [**end pivoted**][**or**][**side pivoted**], with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.

1) Initial Access Opening: In each module, [**24 by 24 inches (610 by 610 mm)**][**As indicated on Drawings**]<**Insert requirements**>.

2.5 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to [**five**]<**Insert safety factor**> times that imposed by ceiling construction, as determined by testing in accordance with ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: [**Cast-in-place**][**Postinstalled expansion**][**Postinstalled bonded**] anchors.
b. Corrosion Protection, Carbon Steel: Components zinc plated in accordance with ASTM B633, Class SC 1 (mild) service condition.
c. Corrosion Protection, Stainless Steel: Components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to [**10**]<**Insert safety factor**> times that imposed by ceiling construction, as determined by testing in accordance with ASTM E1190, conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than [**0.106-inch- (2.69-mm-)**][**0.135-inch- (3.5-mm-)**]<**Insert dimension**> diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed with **0.04-inch- (1-mm-)** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

F. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.

H. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical tiles in-place during a seismic event.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Metal Edge Moldings and Trim :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Armstrong Ceiling & Wall Solutions**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Rockfon; ROCKWOOL International**]
    d. [**USG Corporation**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Armstrong Ceiling & Wall Solutions**]
    b. [**CertainTeed; SAINT-GOBAIN**]
    c. [**Rockfon; ROCKWOOL International**]
    d. [**USG Corporation**]
    e. <**Insert manufacturer's name**>

3. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

    a. Edge moldings to fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
    b. For lay-in panels with reveal edge details, provide [**stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member**]<**Insert description**>.
    c. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
    d. Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**]<**Insert finish**>.

4. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.

    a. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
    b. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.7 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

2.8 MISCELLANEOUS MATERIALS

A. Acoustical Tile Adhesive: Type recommended in writing by acoustical tile manufacturer, bearing UL label for Class 0-25 flame spread.

1. Verify adhesives have a VOC content of [**50**]<**Insert number**> g/L or less.

B. Staples: **5/16-inch-** **(8-mm-)** long, divergent-point staples.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Testing Substrates: Before adhesively bonding tiles to wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.

B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

C. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

A. Install suspended acoustical tile ceilings in accordance with ASTM C636/C636M[**, seismic design requirements,**] and manufacturer's written instructions.

1. Fire-Rated Assembly: Install fire-rated ceiling systems in accordance with tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required[**and, if permitted with fire-resistance-rated ceilings,**] to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or

equivalent devices.

4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than **16 inches (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Arrange directionally patterned acoustical tiles as follows:

1. As indicated on reflected ceiling plans.
2. Install tiles with pattern running in one direction parallel to [**long**][**short**] axis of space.
3. Install tiles in a basket-weave pattern.

G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges of tiles so tile-to-tile joints are interlocked.

1. Fit adjoining tiles to form flush, tight joints. Scribe and cut tiles for accurate fit at borders and around penetrations through ceiling.
2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tiles and moldings, spaced **12 inches (305 mm)** o.c.
3. Protect lighting fixtures and air ducts in accordance with requirements indicated for fire-resistance-rated assembly.

3.4 INSTALLATION OF DIRECTLY ATTACHED ACOUSTICAL TILE CEILINGS

A. Adhesive Installation: Install acoustical tile by bonding to substrate, using acoustical tile adhesive and procedure recommended in writing by tile manufacturer and as follows:

1. Wipe and prime ceiling.
2. Remove loose dust from backs of tiles by brushing.
3. Install splines in joints between tiles and maintain bottom surface to a uniform level. Shim tile or correct substrate as required to maintain levelness.
4. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.

B. Stapled Installation: Fasten acoustical tile to substrate using a minimum of two staples per tile that are installed in flanges of tile and as follows:

1. Form double-lapped joint between tiles by securely pressing tile tongues into corresponding tile grooves.
2. Maintain bottom surface of tiles to a uniform level. Shim tile or correct substrate as required to maintain levelness.
3. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.

C. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical units.

D. Arrange directionally patterned acoustical tiles [**as indicated on Drawings**][**with pattern running in one direction parallel to long axis of space**][**with pattern running in one direction parallel to short axis of space**][**in a basket-weave pattern**]<**Insert requirement**>.

3.5 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of [**1/8 inch in 12 feet (3 mm in 3.6 m)**]<**Insert dimensions**>, non-cumulative.

B. Directly Attached Ceilings: Install bottom surface of tiles to a tolerance of [**1/8 inch in 12 feet (3 mm in 3.6 m) and not exceeding 1/4 inch (6 mm) cumulatively**]<**Insert requirement**>.

C. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of [**1/8 inch in 12 feet (3 mm in 3.6 m)**]<**Insert dimensions**>, non-cumulative.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids in accordance with ASCE/SEI 7.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical tile ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no tiles have been installed. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed

installations of acoustical tile ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for **200 lbf (890 N)** of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for **440 lbf (1957 N)** of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Acoustical tile ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 ADJUSTING

A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 23 00

SECTION 09 51 33 00 - ACOUSTICAL METAL PAN CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum pans for acoustical metal pan ceiling.
2. Steel pans for acoustical metal pan ceiling.
3. Stainless steel pans for acoustical metal pan ceiling.
4. Metal suspension system for acoustical, standard-grid metal pan ceilings.
5. Metal suspension system for acoustical, snap-in metal pan ceilings.

B. Related Requirements:

1. Section 079219 "Acoustical Joint Sealants" for acoustical sealant for exposed and concealed joints.
2. Section 095113 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.
3. Section 095123 "Acoustical Tile Ceilings" for ceilings consisting of mineral-base acoustical tiles used with concealed suspension systems, stapling, or adhesive bonding.
4. Section 095423 "Linear Metal Ceilings."
5. Section 095436 "Suspended Decorative Grids."
6. Section 095753 "Security Ceiling Assemblies" for downward-locking panel and plank ceilings for use in security or detention facilities.

C. Products furnished, but not installed, under this Section include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include procedure for cutting metal pans.

1. Aluminum pans for acoustical metal pan ceiling.
2. Steel pans for acoustical metal pan ceiling.
3. Stainless steel pans for acoustical metal pan ceiling.
4. Metal suspension system for acoustical, standard-grid metal pan ceilings.
5. Metal suspension system for acoustical, snap-in metal pan ceilings.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives and sealants, indicating VOC content.
3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements

for low-emitting materials.

4. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For Insulation, indicating compliance with requirements for low-emitting materials.
9. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
10. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
11. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
12. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
13. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
14. Environmental Product Declaration: For each product.
15. Health Product Declaration: For each product.
16. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
17. Environmental Product Declaration: For each product.
18. Environmental Product Declaration: For each product.
19. Environmental Product Declaration: For each product.
20. Third-Party Certifications: For each product.
21. Third-Party Certified Life Cycle Assessment: For each product.

C. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:

1. Metal Pans: Set of [**full-size**][**6-inch- (150-mm-) square**] Samples of each type, finish, color, pattern, and texture. Show pan edge profile.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of **6-inch- (150-mm-)** long Samples of each type, finish, and color.
3. Sound Absorber: Sample of each type matching size of Sample metal pan.

F. Delegated Design Submittals: For design of [**seismic restraints and**]attachment devices.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which suspension systems will be attached.
3. Size and location of access modules for acoustical panels.
4. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. <**Insert item**>.

5. Perimeter moldings.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical metal pan ceiling, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**a qualified testing agency**].

D. Evaluation Reports: For each acoustical metal pan ceiling suspension system[**and anchor and fastener type**].

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Metal Pans: Full-size units[**with sound absorber**] equal to [**2**]<**Insert number**> percent of quantity installed.
2. Suspension-System Components: Quantity of each grid, exposed molding, and trim equal to [**2**]<**Insert number**> percent of quantity installed.
3. Hold-Down Clips: [**Equal to 2 percent of quantity installed**]<**Insert number**>.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical ceiling area as indicated on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical metal pans, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle acoustical metal pans, suspension-system components, and accessories carefully to avoid damaging units and finishes in any way.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [**seismic restraints and**]attachment devices.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E1264 for [**Class A**][**Class B**][**Class C**] materials.
2. Smoke-Developed Index: [**50**][**450**]<**Insert value**> or less.

2.2 ACOUSTICAL METAL PANS, GENERAL

A. Source Limitations: Obtain each type of acoustical metal ceiling pan and supporting suspension system from single source from single manufacturer.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**]<**Insert value**> percent.

C. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**][**50**]<**Insert value**> percent.

D. Recycled Content of Insulation: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

E. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less, except for insulation manufactured without formaldehyde.

H. Insulation shall comply with the requirements of the California Department of Public Health's "Standard

Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

I. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

J. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

K. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

L. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

M. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

N. Acoustical Panel Standard: Provide manufacturer's standard pans of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is **15-3/4 inches (400 mm)** away from test surface in accordance with ASTM E795.

O. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.

1. Aluminum Sheet: Rolled aluminum sheet, complying with **ASTM B209 (ASTM B209M)**; alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
2. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C635/C635M.

    a. Painted Finishes: Electrolytic zinc-coated steel complying with ASTM A879/A879M, **13Z (40G)** coating, surface treatment as recommended by finish manufacturer for type of use and finish indicated.
    b. Chemical/Mechanical Finishes: Uncoated steel sheet complying with ASTM A1008/A1008M with luster or bright finish as required by finisher for applying electroplating or other metallic-finishing processes.

3. Stainless Steel Sheet: Complying with ASTM A240/A240M or ASTM A666, [**Type 304**][**Type 430**]<**Insert type**>.

P. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing in accordance with ASTM E84.

1. Bond fabric layer to panels in the factory with manufacturer's standard nonflammable adhesive.

Q. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of pan, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing in accordance with ASTM E84, and to comply with the following requirements:

1. Plastic Sheet-Wrapped, Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C553, Type I, Type II, or Type III, and as follows:

   a. Mineral-Fiber Type and Thickness: Glass fiber; [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**3 inches (76 mm)**]<**Insert dimension**>.
   b. Mineral-Fiber Density: [**3/4 lb/cu. ft. (12 kg/cu. m)**][**1 lb/cu. ft. (16 kg/cu. m)**][**1-1/2 lb/cu. ft. (24 kg/cu. m)**]<**Insert value**>.
   c. Plastic Sheet Thickness and Color: Not less than **0.003 inch (0.076 mm)**; [**clear**][**flat black**][**white**].

2. Unwrapped, Glass-Fiber Insulation: Black coated, unfaced, complying with ASTM C553, Type I, Type II, or Type III; treated to be nondusting; [**1 inch (25 mm)**][**1-1/2 inches (38 mm)**]<**Insert dimension**> thick.
3. Spacer Grids: Provide manufacturer's standard [**aluminum**][**galvanized-steel**] grid units that provide an air cushion between metal pans and insulation pads and that act to improve sound absorption.

R. Sound Attenuation Panels: Provide manufacturer's standard [**aluminum**][**galvanized-steel**] unperforated metal backing unit that acts as a sound attenuation pan to reduce sound travel through ceiling plenum into adjoining rooms.

1. Sound-Absorbent Pads: Provide secondary sound-absorbent pads, [**same as specified for primary sound-absorbent pads**]<**Insert requirements**>, for placement over sound attenuation pan to reduce plenum sound.

S. Adhesive: Manufacturer's standard nonflammable adhesive for sound-absorbent [**fabric**][**and**][**pads**].

1. Adhesives shall have a VOC content of [**70**]<**Insert value**> g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.3 ALUMINUM PANS FOR ACOUSTICAL METAL PAN CEILING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Decorative Ceilings, Inc.**]
2. [**Armstrong Ceiling & Wall Solutions**]
3. [**CertainTeed; SAINT-GOBAIN**]
4. [**Gage Corporation International (The)**]
5. [**Lindner Group**]
6. [**Rockfon; ROCKWOOL International**]
7. [**USG Corporation**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Decorative Ceilings, Inc.**]
2. [**Armstrong Ceiling & Wall Solutions**]
3. [**CertainTeed; SAINT-GOBAIN**]
4. [**Gage Corporation International (The)**]
5. [**Lindner Group**]
6. [**Rockfon; ROCKWOOL International**]
7. [**USG Corporation**]
8. <**Insert manufacturer's name**>

C. Classification: Units complying with ASTM E1264 for [**Type VII, perforated aluminum facing (pan) with mineral- or glass-fiber-base backing**][**Type XX, other types described as perforated aluminum facing (pan) units with sound-absorbent fabric backing**][**Type XX, other types described as unperforated aluminum facing (pan) units**]<**Insert Type XX description**>.

1. Pattern A: Perforated, regularly spaced large holes, arranged in [**diagonal**][**parallel**] alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**indicated by product designation**][**selected from manufacturer's full range**].
2. Pattern B: Perforated, small holes regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**specified by product designation**][**selected from manufacturer's full range**].
3. Pattern: <**Insert pattern designation for perforated pans and any requirements for perforation alignment, hole shape and size, holes per square foot or inch, percent open area, and border requirements**>.

D. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.
5. <**Insert type and description**>.

E. Pan Thickness: Not less than [**0.019 inch (0.5 mm)**][**0.025 inch (0.6 mm)**][**0.032 inch (0.8 mm)**][**0.040 inch (1.0 mm)**]<**Insert dimension**>.

F. Pan Edge Detail: [**Square**][**Beveled**][**Reveal**][**Manufacturer's standard edge detail**].

G. Pan Joint Detail: [**Butt**][**Wide reveal, not less than 15/16 inch (24 mm) wide**][**Narrow reveal, not greater than 9/16 inch (15 mm) wide**][**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**]<**Insert description**>.

H. Pan Size: [**12 by 12 inches (305 by 305 mm)**][**12 by 24 inches (305 by 610 mm)**][**12 by 36 inches (305 by 915 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1220 mm)**][**24 by 60 inches (610 by 1525 mm)**][**30 by 30 inches (760 by 760 mm)**][**30 by 60 inches (760 by 1525 mm)**][**As indicated on Drawings**]<**Insert dimensions**>.

I. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**]<**Insert dimensions**> ceiling units.

J. Pan Face Finish: [**Mill**][**Lacquered mill**][**Clear anodized**][**Clear mirror anodized**][**Painted white**][**Painted to match color indicated by product designation**][**Painted to match Architect's sample**][**Painted in color selected from manufacturer's full range**][**Bright-reflective metallic finish selected from manufacturer's full range**]<**Insert finish**>.

K. Light Reflectance Coefficient: Not less than [**0.70**][**0.75**]<**Insert number**>.

L. NRC: Not less than [**0.60**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**][**0.95**]<**Insert number**>.

M. Ceiling Attenuation Class: Not less than [**35**][**40**][**45**]<**Insert number**>.

2.4 STEEL PANS FOR ACOUSTICAL METAL PAN CEILING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Decorative Ceilings, Inc.**]
2. [**Armstrong Ceiling & Wall Solutions**]
3. [**CertainTeed; SAINT-GOBAIN**]
4. [**Lindner Group**]
5. [**Rockfon; ROCKWOOL International**]
6. [**USG Corporation**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Decorative Ceilings, Inc.**]
2. [**Armstrong Ceiling & Wall Solutions**]
3. [**CertainTeed; SAINT-GOBAIN**]
4. [**Lindner Group**]
5. [**Rockfon; ROCKWOOL International**]
6. [**USG Corporation**]
7. <**Insert manufacturer's name**>

C. Classification: Units complying with ASTM E1264 for [**Type V, perforated steel facing (pan) with mineral- or glass-fiber-base backing**][**Type XX, other types described as perforated steel facing (pan) units with sound-absorbent fabric backing**][**Type XX, other types described as unperforated steel facing (pan) units**]<**Insert Type XX description**>.

1. Pattern A: (Perforated, regularly spaced large holes), arranged in [**diagonal**][**parallel**] alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**indicated by product designation**][**selected from manufacturer's full range**].
2. Pattern B: (Perforated, small holes) regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as [**specified by product designation**][**selected from manufacturer's full range**].
3. Pattern: <**Insert pattern designation for perforated pans and any requirements for perforation alignment, hole shape and size, holes per square foot or inch, and percent open area**>.

D. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.
5. <**Insert type and description**>.

E. Pan Thickness: Not less than [**0.010 inch (0.25 mm)**][**0.019 inch (0.5 mm)**][**0.025 inch (0.6 mm)**][**0.030 inch (0.75 mm)**][**0.036 inch (0.9 mm)**]<**Insert dimension**>.

F. Pan Edge Detail: [**Square**][**Beveled**][**Reveal**][**Manufacturer's standard edge detail**].

G. Pan Joint Detail: [**Butt**][**Wide reveal, not less than 15/16 inch (24 mm) wide**][**Narrow reveal, not greater than 9/16 inch (15 mm) wide**][**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**]<**Insert description**>.

H. Pan Size: [**12 by 12 inches (305 by 305 mm)**][**12 by 24 inches (305 by 610 mm)**][**12 by 36 inches (305 by 915 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1220 mm)**][**24 by 60 inches (610 by 1525 mm)**][**30 by 30 inches (760 by 760 mm)**][**30 by 60 inches (760 by 1525 mm)**][**As indicated on Drawings**]<**Insert dimensions**>.

I. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**]<**Insert dimensions**> ceiling units.

J. Pan Face Finish: [**Painted white**][**Painted to match color indicated by product designation**][**Painted to match Architect's sample**][**Painted in color selected from manufacturer's full range**][**Plated with metallic finish, as selected from manufacturer's full range**][**Bright-reflective metallic finish selected from manufacturer's full range**]<**Insert finish**>.

K. Light Reflectance Coefficient: Not less than [**0.70**][**0.75**]<**Insert number**>.

L. NRC: Not less than [**0.60**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**][**0.95**]<**Insert number**>.

M. Ceiling Attenuation Class: Not less than [**35**][**40**][**45**]<**Insert number**>.

2.5 STAINLESS STEEL PANS FOR ACOUSTICAL METAL PAN CEILING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Ceiling & Wall Solutions**]
2. [**Rockfon; ROCKWOOL International**]
3. [**USG Corporation**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong Ceiling & Wall Solutions**]
2. [**Rockfon; ROCKWOOL International**]
3. [**USG Corporation**]
4. <**Insert manufacturer's name**>

C. Classification: Units complying with ASTM E1264 for [**Type VI, perforated stainless steel facing (pan) with mineral- or glass-fiber-base backing**][**Type XX, other types described as perforated stainless steel facing (pan) units with sound-absorbent fabric backing**][**Type XX, other types described as unperforated stainless steel facing (pan) units**]<**Insert Type XX description**>.

1. Pattern A: (Perforated, regularly spaced large holes), arranged in parallel alignment to pan edge with uniform perforations of **0.109-inch (2.8-mm)** diameter, 1800 holes/sq. ft. or inch, and 11.8 percent open area.
2. Pattern: <**Insert pattern designation for perforated pans and any requirements for perforation alignment, hole shape and size, holes per square foot or inch, and percent open area**>.

D. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Lay-in Pans: Formed to set in exposed suspension grid.
2. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
3. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
4. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.
5. <**Insert type and description**>.

E. Pan Thickness: Not less than [**0.019 inch (0.5 mm)**][**0.025 inch (0.6 mm)**][**0.030 inch (0.76 mm)**]<**Insert dimension**>.

F. Pan Edge Detail: [**Square**][**Beveled**][**Reveal**][**Manufacturer's standard edge detail**].

G. Pan Joint Detail: [**Butt**][**Wide reveal, not less than 15/16 inch (24 mm) wide**][**Narrow reveal, not greater than 9/16 inch (15 mm) wide**][**Flush narrow reveal, not greater than 9/16 inch (15 mm) wide**]<**Insert description**>.

H. Pan Size: [**12 by 12 inches (305 by 305 mm)**][**12 by 24 inches (305 by 610 mm)**][**12 by 36 inches (305 by 915 mm)**][**24 by 24 inches (610 by 610 mm)**][**24 by 48 inches (610 by 1220 mm)**][**30 by 30 inches (760 by 760 mm)**][**As indicated on Drawings**]<**Insert dimensions**>.

I. Scoring: Score pans at intervals to appear as [**12-by-12-inch (305-by-305-mm)**]<**Insert dimensions**> ceiling units.

J. Pan Face Finish: [**Directional Satin Finish: ASTM A480/A480M No. 4**][**Dull Satin Finish: ASTM A480/A480M No. 6**][**Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M No. 8**]<**Insert**

finish>.

K. NRC: Not less than [**0.60**][**0.65**][**0.70**][**0.75**][**0.80**][**0.85**][**0.90**][**0.95**]<**Insert number**>.

L. Ceiling Attenuation Class: Not less than [**35**][**40**][**45**]<**Insert number**>.

2.6 METAL SUSPENSION SYSTEMS, GENERAL

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

B. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

C. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

D. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

E. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C635/C635M requirements.

H. Suspension Systems: Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.

I. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.

J. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.

K. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.

L. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel copper alloy for UNS No. N04400 alloy.
4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung, is less than yield stress of wire, but provide not less than [**0.106-inch- (2.69-mm-)**][**0.135-inch- (3.5-mm-)**]<**Insert dimension**> diameter wire.

M. Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

N. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed with **0.04-inch- (1.0-mm-)** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

O. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

P. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

Q. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical metal pans in place.

R. Hold-Down Clips: Manufacturer's standard hold-down clips spaced to secure acoustical metal pans in place [**to molding and trim at perimeter**][**at each pan**]<**Insert requirements**>.

S. Exposed Metal Edge Moldings and Trim: Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching acoustical metal pan ceiling units unless otherwise indicated.

1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.7 METAL SUSPENSION SYSTEM FOR ACOUSTICAL, STANDARD-GRID METAL PAN CEILINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Armstrong Ceiling & Wall Solutions**]
2. [**CertainTeed; SAINT-GOBAIN**]
3. [**Rockfon; ROCKWOOL International**]
4. [**USG Corporation**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Armstrong Ceiling & Wall Solutions**]
2. [**CertainTeed; SAINT-GOBAIN**]
3. [**Rockfon; ROCKWOOL International**]
4. [**USG Corporation**]
5. <**Insert manufacturer's name**>

C. Suspension System: For [**clip-in**][**lay-in**][**torsion-spring-hinged**]<**Insert type**> pans.

1. Wide-Face, Capped, Double-Web, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized in accordance with ASTM A653/A653M, **G30 (Z90)** coating designation, with prefinished, cold-rolled, **15/16-inch- (24-mm-)** wide, sheet metal caps on flanges.

    a. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
    b. End Condition of Cross Runners: [**Override (stepped)**][**or**][**butt-edge**] type.
    c. Face Design: Flat, flush.
    d. Cap Material: [**Steel**][**or**][**aluminum**] cold-rolled sheet.
    e. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of metal pan**][**Plated with metallic finish, as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**][**Natural finish for aluminum**].

2. Narrow-Face, Capped, Double-Web, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized in accordance with ASTM A653/653M, **G30 (Z90)** coating designation, with prefinished, cold-rolled, **9/16-inch- (15-mm-)** wide, sheet metal caps on flanges.

    a. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
    b. End Condition of Cross Runners: [**Override (stepped)**][**or**][**butt-edge**] type.
    c. Face Design: [**Flat, flush**][**Flanges formed with an integral center reveal**].
    d. Cap Material: [**Steel**][**or**][**aluminum**] cold-rolled sheet.
    e. Cap Finish: [**Painted white**][**Painted in color as selected from manufacturer's full range**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of metal pan**][**Plated with metallic finish, as selected from manufacturer's full range**][**Plated with metallic finish indicated by manufacturer's designation**][**Natural finish for aluminum**].

3. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized, to produce structural members with **9/16-inch- (15-mm-)** wide faces.

    a. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
    b. Face Design: With [**1/8-inch- (3.2-mm-)**][**1/4-inch- (6.35-mm-)**] wide, slotted, box-shaped flange.
    c. Face Finish: Painted [**white**][**in color as selected from manufacturer's full range**][**to match color indicated by manufacturer's designation**][**to match color of metal pan**].

4. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized in accordance with ASTM A653/A653M, **G60 (Z180)** coating designation, with prefinished, cold-rolled, **15/16-inch- (24-mm-)** wide, aluminum caps on flanges.

    a. Structural Classification: [**Intermediate**][**Heavy**]-duty system.
    b. Face Design: Flat, flush.
    c. Face Finish: [**Painted white**][**Painted to match color indicated by manufacturer's designation**][**Painted to match color of acoustical unit**][**Natural finish**].

5. Wide-Face, Capped, Double-Web, Stainless Steel Suspension System: Main and cross runners roll formed from and capped with Type 304 or Type 316 stainless steel sheet, with prefinished, cold-rolled, **15/16-inch- (24-mm-)** wide, stainless steel caps on flanges.

a. Structural Classification: Intermediate-duty system.
b. Face Design: Flat, flush.
c. Finish: [**Directional Satin Finish: ASTM A480/A480M No. 4**][**Dull Satin Finish: ASTM A480/A480M No. 6**][**Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M No. 8**]<**Insert finish**>.

6. Suspension System for Torsion-Spring-Hinged Metal Pans: Provide runners with factory-cut slots fabricated to accept torsion-spring-hinged attachment.

2.8 METAL SUSPENSION SYSTEM FOR ACOUSTICAL SNAP-IN METAL PAN CEILINGS

A. Snap-In Grid Suspension System: .

1. Manufacturers: Subject to compliance with requirements, provide products by snap-in metal pan ceiling manufacturer.

B. Indirect-Hung, Snap-in System: Designed to support metal pans that snap into main runners, consisting of main runners connected to carrying channels that are attached by hangers to building structure, and complying with the following requirements:

1. Main Runners: Formed from the following metal:

a. Aluminum Sheet: Alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with **ASTM B209 (ASTM B209M)**.
b. Electrolytic Zinc-Coated Steel Sheet: ASTM A879/A879M, with not less than [**08Z (24G)**]<**Insert coating designation**> zinc coating.
c. Hot-Dip Galvanized Steel: ASTM A653/A653M, with not less than [**G60 (Z180)**]<**Insert coating designation**> zinc coating.
d. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 302 or Type 304, stretcher leveled, with cold-rolled mill finish.
e. Metal Sheet: Metal as standard with ceiling system manufacturer, with factory-applied protective finish complying with ASTM C635/C635M.

2. Carrying Channels:

a. Same member and metal as indicated for main runners.
b. Cold-rolled steel, not less than **0.060-inch (1.5-mm)** nominal thickness of base (uncoated) metal and **7/16-inch- (11-mm-)** wide flanges, [**protected with rust-inhibitive paint**][**hot-dip galvanized in accordance with ASTM A653/A653M, G60 (Z180) coating designation**], and as follows:

1) Depth and Weight: [**1-1/2 inches and 475 lb/1000 feet (38 mm and 215 kg/305 m)**][**2 inches and 590 lb/1000 feet (51 mm and 268 kg/305 m)**].

C. Direct-Hung, Snap-in System: Designed to support metal pans that snap into main runners, consisting of main runners supported by hangers attached directly to building structure, and complying with the following requirements:

1. Hangers: Angles or channels, as standard with ceiling system manufacturer, formed from same metal as main runners.
2. Main Runners: Rolled aluminum sheet; alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with **ASTM B209 (ASTM B209M)**.

D. Access Panels: For access at locations indicated, provide acoustical snap-in metal pan ceiling units, accessible by [**key or tool**][**two access knobs; place one access knob at each end of panel near corners**].

1. Access Key or Tool: Provide manufacturer's standard key or tool for opening access panels; [**one**][**two**]<**Insert number**>.

2.9 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

2.10 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. High-Humidity Finish: Comply with ASTM C635/C635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

2.11 ALUMINUM FINISHES

A. Mill Finish: AA-M10C10 (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned).

B. Lacquered Mill Finish: AA-M10C10R1x (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned; Organic Coating: as specified below).

1. Organic Coating: Manufacturer's standard clear organic coating.

C. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

D. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.

E. Color-Coated Finish: Manufacturer's standard[**powder-coat**] baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

F. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

2.12 METALLIC-COATED STEEL SHEET FINISHES

A. Color-Coated Finish: Manufacturer's standard[**powder-coat**] baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

2.13 STEEL SHEET FINISHES

A. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.

B. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

2.14 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical metal pan ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical metal pan ceilings.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and coordination drawings.

3.3 INSTALLATION OF ACOUSTICAL METAL PAN CEILINGS

A. General: Install acoustical metal pan ceiling assemblies to comply with ASTM C636/C636M[**, seismic design requirements,**] and manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum

that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required[**and, if permitted with fire-resistance-rated ceilings,**] to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members[**or carrying channels**] and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that do not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to ceiling suspension members[**or carrying channels**] and to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members[**or carrying channels**] and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than **16 inches (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends, leveling with ceiling suspension system to a tolerance of **1/8 inch in 12 feet (3.2 mm in 3.6 m)**. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Cut acoustical metal pan units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet. Cut and treat edges to comply with manufacturer's written instructions.

G. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim. Comply with manufacturer's installation tolerances.

1. For lay-in, square-edge pans, install pans with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. For lay-in, reveal-edge pans on suspension-system runners, install pans with bottom of reveal in firm contact with top surface of runner flanges.
3. For lay-in, reveal-edge pans on suspension-system members with box-shaped flanges, install pans with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
4. For [**clip-in**][**torsion-spring-hinged**] pans, position pans in accordance with manufacturer's written instructions.
5. For snap-in pans, fit adjoining units to form flush, tight joints.
6. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
7. Fit adjoining units to form flush, tight joints.
8. Install directionally patterned or textured metal pans in directions indicated.
9. Install sound-absorbent fabric layers in, and bond to, perforated metal pans.
10. Install sound-absorbent pads in perforated metal pans[**over metal spacer grids**].

H. Install sound attenuation panels in areas indicated by reflected ceiling plans or room finish schedules. Lay panels directly on ceiling system and close major openings to form complete coverage in required areas. Lay second sound-absorbent pads on sound attenuation panels.

I. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Seismic design compliance.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical metal panel ceiling hangers, anchors, and fasteners in successive stages. Do not proceed with installations of acoustical metal panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.

1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed.

a. Within each test area, testing agency selects one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and tests them for **200 lbf (890 N)** of tension; it also selects one of every two postinstalled anchors used to attach bracing wires to concrete and tests them for **440 lbf (1957 N)** of tension.
b. When tested fasteners and anchors do not comply with requirements, testing agency tests those fasteners and anchors not previously tested until 20 pass consecutively and then resumes initial testing frequency.

D. Acoustical metal panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. Clean exposed surfaces of acoustical metal pan ceilings, including trim and edge moldings, after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 09 51 33 00

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Task	Specification	Specification Description
09 51 33 13	09 51 33 00	Acoustical Metal Pan Ceilings
09 51 33 23	09 51 33 00	Acoustical Metal Pan Ceilings
09 51 33 33	09 51 33 00	Acoustical Metal Pan Ceilings
09 53 23 00	09 51 13 00	Acoustical Panel Ceilings

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SECTION 09 54 00 00 - STRETCHED-FABRIC CEILING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Stretched-fabric ceiling systems.

B. Related Requirements:

1. Section 095446 "Fabric-Wrapped Ceiling Panels" for decorative, fabric-wrapped ceiling panels that are not required to be tested for acoustical performance[**and for coordinated requirements for fabric**].
2. Section 097200 "Wall Coverings" for adhesively applied textile wall coverings[**and for coordinated requirements for fabric**].
3. Section 097713 "Stretched-Fabric Wall Systems" for site-upholstered systems applied to walls[**and for coordinated requirements for fabric**].
4. Section 098436 "Sound-Absorbing Ceiling Units" for shop-fabricated, acoustical ceiling panels tested for acoustical performance[**and for coordinated requirements for fabric**].

1.2 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound absorption average.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data: For stretched-fabric ceiling systems.

1. Include[**fabric facing,**] frame edge and trim, core material, and mounting indicated.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
6. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.

7. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
8. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
9. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
10. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
11. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each stretched-fabric system.

1. Include the following:

   a. Reflected ceiling plans, elevations, sections, and installation and system details.
   b. Details at joints and corners; and details at ceiling intersections and intersections with walls. Indicate frame-edge profile and core materials.
   c. Details at cutouts and penetrations for other work.
   d. Direction of fabric weave and pattern matching.

2. Show sewn-seam locations, types, and methods.

D. Samples for Initial Selection: For each type of fabric facing.

1. Include accessories involving color or finish selection.

E. Samples for Verification: For the following:

1. Fabric: Full-width by approximately [**36-inch- (900-mm-)**]<**Insert dimension**> long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Frame System: **12-inch- (300-mm-)** square Sample(s) showing each edge profile and corner.
3. Core Material: **12-inch- (300-mm-)** square Sample at corner.
4. Assembled System: Approximately **36 by 36 inches (900 by 900 mm)**, including joints[**and seams**] in mockup.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets.
2. Suspended ceiling components above stretched-fabric systems.
3. Structural members to which suspension devices will be attached.
4. Items penetrating or covered by stretched-fabric systems including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Alarms.
   e. Sprinklers.
   f. Access panels.
   g. <**Insert item**>.

5. Show operation of hinged and sliding components covered by or adjacent to stretched-fabric systems.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of stretched-fabric system.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stretched-fabric systems to include in maintenance manuals. Include fabric manufacturer's written cleaning, stain-removal, restretching, and reupholstering instructions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, furnish length equal to [**10**]<**Insert number**> percent of amount installed, but no fewer than [**10 sq. yd. (9 sq. m)**]<**Insert quantity**>, full width of bolt.
2. Framing and Related Installation Items: Furnish manufacturer's full-length units equal to [**5**]<**Insert number**> percent of amount installed, but no fewer than [**5**]<**Insert number**> units, including unopened adhesives.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical ceiling area[**as shown on Drawings**][**96 inches (2400 mm) wide by full width of ceiling**]<**Insert dimensions**>.[**Include intersection of wall and ceiling, corners, and perimeters.**]
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and stretched-fabric system manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install stretched-fabric systems until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install stretched-fabric systems until [**a permanent level of lighting**][**a lighting level of not less than 50 fc (538 lx)**]<**Insert requirement**> is provided on surfaces to receive stretched-fabric systems.

C. Air-Quality Limitations: Protect stretched-fabric systems from exposure to airborne odors, such as tobacco smoke, and install systems under conditions free from odor contamination of ambient air.

1.11 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of stretched-fabric systems that fail in performance, materials, or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Acoustical performance.
b. Fabric sagging, distorting, or releasing from panel edge.
c. Warping of core.

2. Warranty Period: [**Two**][**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain stretched-fabric ceiling systems specified in this Section[**and stretched-fabric wall systems specified in Section 097713 "Stretched-Fabric Wall Systems"**] from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Fire-Test-Response Characteristics: Stretched-fabric ceiling systems comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency on systems prepared in accordance with ASTM E2573. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: [**450**]<**Insert value**> or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with NFPA 286.

2.3 STRETCHED-FABRIC CEILING SYSTEMS

A. Stretched-Fabric Ceiling System : Manufacturer's standard system consisting of facing material stretched tightly over a frame[**and core material**] and secured in the frame.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Accutrack Systems, LLC**]
   b. [**Acoustical Fabric Systems Inc**]
   c. [**Novawall Systems, Inc**]
   d. [**SnapTex International LLC**]
   e. [**SoftWalls, Inc.**]
   f. [**Whisper Walls**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Accutrack Systems, LLC**]
   b. [**Acoustical Fabric Systems Inc**]
   c. [**Novawall Systems, Inc**]
   d. [**SnapTex International LLC**]
   e. [**SoftWalls, Inc.**]
   f. [**Whisper Walls**]
   g. <**Insert manufacturer's name**>

3. Core: [**Manufacturer's standard**][**Glass-fiber board**][**Glass-fiber blanket**][**Mineral-fiber board**][**Cementitious-fiber board**][**Medium-density fiberboard**][**Particleboard**]<**Insert requirement**>.

   a. Nominal Core Thickness: [**Match nominal frame thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on**

Drawings]<**Insert dimension**>.

4. Core Overlay: Polyester batting [**1/2 inch (13 mm) thick**][**Manufacturer's standard thickness**]<**Insert dimension**>.
5. Frame Edge: [**Chamfered (beveled)**][**Radiused (bullnosed)**][**Square**]<**Insert profile**> profile.

    a. Fabric-Insertion Point: [**Bottom load**][**Side load**][**Top load**].
    b. Nominal Frame Thickness: [**Match nominal core thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**]<**Insert dimension**>.

6. Frame Color: [**Natural**][**Black**][**White**][**Prepainted color as selected by Architect from full range of manufacturer's colors**]<**Insert requirement**>.
7. Reveals between Panels: [**Recessed**][**Flush**][**Projecting**] reveals [**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**]<**Insert requirement**>.
8. Facing Material: [**Owner-furnished material**][**As indicated on Drawings**]<**Insert drawing designation**>.
9. Acoustical Performance: Sound absorption [**NRC**][**or**][**SAA**] of [**0.50 to 0.90**][**0.60 to 0.70**][**0.65 to 0.75**][**not less than 0.65**][**not more than 0.35**]<**Insert range or single value**> in accordance with ASTM C423 for [**Type A**]<**Insert mounting**> mounting in accordance with ASTM E795.
10. Nominal Overall System Thickness: [**Match nominal frame thickness**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**2 inches (51 mm)**][**As indicated on Drawings**]<**Insert dimension**>.

2.4 MATERIALS

A. Sustainable Design Requirements:

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:

    a. Hardwood Plywood: 0.05 ppm.
    b. Particleboard: 0.09 ppm.
    c. MDF More Than **5/16 Inch (8 mm)** Thick: 0.11 ppm.
    d. MDF **5/16 Inch (8 mm)** or Less in Thickness: 0.13 ppm.

5. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Core Materials:[**Manufacturer's standard.**]

1. Glass-Fiber Board: ASTM C612, of type standard with manufacturer; nominal density of [**6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**]<**Insert values**>, unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Glass-Fiber Blanket: ASTM C553, ASTM C612, or ASTM C665; of type standard with manufacturer; nominal density of [**3 to 4 lb/cu. ft. (48 to 64 kg/cu. m)**]<**Insert values**>; flexible;

and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

3. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of [**13 lb/cu. ft. (208 kg/cu. m)**][**20 lb/cu. ft. (320 kg/cu. m)**], and with perforated surface.
4. Cementitious-Fiber Board: Density of not less than [**20 lb/cu. ft. (320 kg/cu. m)**]<**Insert value**>.
5. Medium-Density Fiberboard: Panels complying with ANSI A208.2, [**grade to suit performance requirements**][**Grade 130**]<**Insert grade**>.

    a. Fire-retardant panels made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less when tested in accordance with ASTM E84 or UL 723.

6. Particleboard: Panels complying with ANSI A208.1, [**grade to suit performance requirements**][**Grade M-2**]<**Insert grade**>.

    a. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less when tested in accordance with ASTM E84 or UL 723.

7. Core Overlay: Flame-retardant, compressible, fiberfill, polyester batting.

C. Frame Construction: Manufacturer's standard, continuous, extruded plastic frame (track).

D. Facing Material : Fabric from same dye lot; color and pattern [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**]<**Insert requirement**>.

1. Manufacturer: <**Insert manufacturer's name**>.
2. Product Line/Pattern: <**Insert product name or designation**>.
3. Pattern Repeat: <**Insert requirement**>.
4. Style Number: <**Insert number**>.
5. Color: <**Insert name or number, or both**>.
6. Fiber Content: [**100**]<**Insert number**> percent [**woven polyester**][**nonwoven polyester**][**polyolefin**][**acoustically transparent vinyl**]<**Insert fiber requirement**>.
7. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**]<**Insert dimension**>.
8. Source: <**Insert fabric-vendor's name**>.
9. Applied Treatments: [**Stain resistance**][**flame retardant**][**acrylic backing, single coat**][**acrylic backing, double coat**][**latex backing**][**foam backing**][**and**][**knit backing**]<**Insert treatment**>.
10. Light Reflectance: Average value not less than [**0.75**]<**Insert value**> when tested in accordance with ASTM E1477.
11. Lining Material: [**Manufacturer's standard fabric for each use indicated**]<**Insert material designation**>.
12. Trim Strip: <**Insert material designation**>.

E. Lining Material <**Insert material designation**>: Fabric [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**]<**Insert requirement**>.

1. Manufacturer: <**Insert manufacturer's name**>.
2. Product Line: <**Insert product name or designation**>.
3. Style Number: <**Insert number**>.
4. Color: [**White**]<**Insert name or number, or both**>.
5. Fiber Content: <**Insert content by percentage and fiber type**>.
6. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**]<**Insert dimension**>.

7. Source: <**Insert fabric-vendor's name**>.
8. Applied Treatments: [**Stain resistance**][**and**][**flame retardant**]<**Insert treatment**>.

F. Trim Strip <**Insert material designation**>: Fabric [**matching facing material except as follows**]<**Insert requirement**>.

1. Product Line: <**Insert product name or designation**>.
2. Style Number: <**Insert number**>.
3. Color: [**White**]<**Insert name or number, or both**>.

2.5 INSTALLATION MATERIALS

A. Installation Products: Concealed on back of system, recommended by stretched-fabric system manufacturer to support weight of system, fabric tension, and as follows:

1. Adhesives shall have a VOC content of [**70**]<**Insert value**> g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
7. Fasteners: [**Manufacturer's standard**]<**Insert requirement**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, materials, substrates, areas, and conditions, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of stretched-fabric systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each area and establish layout of panels and joints of [**uniform size with balanced borders at opposite edges**][**sizes indicated on Drawings**] within a given area.

B. Before installation, allow fabric to adjust and become stable in spaces where it will be installed according to stretched-fabric system manufacturer's written instructions. Acclimatize fabric for minimum of [**24**]<**Insert number**> hours at ambient temperature and humidity conditions indicated for spaces when occupied for their intended use.

3.3 INSTALLATION OF STRETCHED-FABRIC CEILING SYSTEMS

A. Install stretched-fabric ceiling systems according to system manufacturer's written instructions.

1. Provide continuous perimeter frames of each profile indicated, designed to be inconspicuous when covered by fabric facing, with smooth edges, and with surface finish that will not telegraph through fabric facing.
2. Install framing around penetrations.
3. Tightly fit framing to adjacent construction and securely attach to substrate.
4. Install core material with full coverage, flush with face of stretched-fabric system frame.
5. Attach frame and core to substrate with adhesive or fasteners, or both, to support system and prevent deformation of components.
6. Install stretched-fabric systems true in plane and with fabric square to the grain.
7. Install jointed panels with [**butt joints**][**and**][**reveals**]<**Insert requirement**> as indicated.

B. Fabric Installation: Apply fabric monolithically in continuous run over area, without joints or reveals, except where panel joints or midspan frames are indicated.

1. Fabric Direction: Run fabric [**as indicated on Drawings**]<**Insert requirement**>.
2. Fabric Sequence: Maintain sequence of fabric drops; match and level fabric pattern and grain.
3. Fabric Alignment: Install fabric with patterns or directional weaves so pattern or weave [**aligns with adjacent panels**][**varies from adjacent panels as indicated on Drawings**].
4. Fabric Seams:

    a. Sewn seams are not permitted.
    b. [**Manufacturer's standard**][**Flat standard**][**French**][**Welt-trimmed**]<**Insert description**> sewn seams, straight and parallel; seam dimensions and locations as indicated on Drawings.

5. Core Overlay: Evenly stretch over core face and edges; free from puckers, ripples, wrinkles, and sags.
6. Stretch and secure fabric to frame edges and so frame and frame attachment method are concealed by fabric unless otherwise indicated.
7. Stretch fabric tightly and square without puckers, ripples, or distortions. Acclimatize and restretch if recommended by stretched-fabric system manufacturer. Repair distortions, wrinkles, and sagging.
8. Trim Strip: Back-wrap trim strip fabric from the fabric-insertion point over the exposed part of the frame edge where indicated, resulting in a contrasting fabric along the edge.

3.4 INSTALLATION TOLERANCES

A. Edge Straightness: Plus or minus [**1/16 inch (1.6 mm)**]<**Insert dimension**> in **48 inches (1200 mm)**.

B. Variation from Alignment with Surfaces: Plus or minus [**1/16 inch (1.6 mm)**]<**Insert dimension**> in **48 inches (1200 mm)**, noncumulative.

C. Variation from Level or Slope: Plus or minus [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**]<**Insert dimension**>.

D. Variation of Joint Width: Not more than [1/16 inch (1.6 mm)]<**Insert dimension**> in 48 inches (1200 mm) from [**hairline**][**reveal line**], noncumulative.

3.5 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 09 54 00 00

SECTION 09 54 00 00A - FABRIC-WRAPPED CEILING PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Shop-fabricated, fabric-wrapped ceiling panels.

B. Related Requirements:

1. Section 095443 "Stretched-Fabric Ceiling Systems" for site-upholstered systems applied to ceilings[**and for coordinated requirements for fabric**].
2. Section 097200 "Wall Coverings" for adhesively applied textile wall coverings[**and for coordinated requirements for fabric**].
3. Section 098436 "Sound-Absorbing Ceiling Units" for shop-fabricated, acoustical ceiling panels tested for acoustical performance[**and for coordinated requirements for fabric**].

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data: For each product.

1. Include[**fabric facing,**] panel edge, core material, and mounting indicated.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
5. Chain-of-Custody Qualification Data: For manufacturer and vendor.
6. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
9. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For panel assembly and installation.

1. Include reflected ceiling plans, elevations, sections, and mounting devices and details.
2. Include details at joints and corners; and details at ceiling intersections and intersections with walls. Indicate panel edge profile and core materials.
3. Include direction of fabric weave and pattern matching.

D. Samples for Initial Selection: For each type of fabric facing.

1. Include Samples of hardware and accessories involving color or finish selection.

E. Samples for Verification: For the following products:

1. Fabric: Full-width by approximately [**36-inch- (900-mm-)**]<**Insert dimension**> long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Panel Edge: **12-inch- (300-mm-)** long Sample(s) showing each edge profile, corner, and finish.
3. Core Material: **12-inch- (300-mm-)** square Sample at corner.
4. Mounting Devices: Full-size Samples.
5. Assembled Panels: Approximately **36 by 36 inches (900 by 900 mm)**, including joints and mounting methods.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets.
2. Suspended ceiling components above ceiling panels.
3. Structural members to which suspension devices will be attached.
4. Items penetrating or covered by panels including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Alarms.
    e. Sprinklers.
    f. Access panels.
    g. <**Insert item**>.

5. Show operation of hinged and sliding components covered by or adjacent to panels.

B. Product Certificates: For each type of panel.

C. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of panel to include in maintenance manuals. Include fabric manufacturer's written cleaning and stain-removal instructions.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, furnish length equal to [**10**]<**Insert number**> percent of amount installed, but no fewer than [**10 sq. yd. (9 sq. m)**]<**Insert quantity**>, full width of bolt.
2. Mounting Devices: Full-size units equal to [**5**]<**Insert number**> percent of amount installed, but no fewer than [**five**]<**Insert number**> devices.

1.7 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical ceiling area[**as shown on Drawings**][**96 inches (2400 mm) wide by full width of ceiling**]<**Insert dimensions**>.[**Include intersection of wall and ceiling, corners, and perimeters.**]
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install panels until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install fabric-wrapped ceiling panels until [**a permanent level of lighting**][**a lighting level of not less than 50 fc (538 lx)**]<**Insert requirement**> is provided on surfaces to receive the panels.

C. Air-Quality Limitations: Protect panels from exposure to airborne odors, such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify panel locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace panels and components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Fabric sagging, distorting, or releasing from panel edge.
b. Warping of core.

2. Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fabric-wrapped ceiling panels[**and fabric-wrapped wall panels specified in Section 097723 "Fabric-Wrapped Panels"**] from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

D. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Fire-Test-Response Characteristics: Panels are to comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: [**450**]<**Insert value**> or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with NFPA 286.

2.3 SHOP-FABRICATED FABRIC-WRAPPED CEILING PANELS

A. Fabric-Wrapped Ceiling Panel : Manufacturer's standard panel construction consisting of facing material [**laminated to front face, edges, and back edge border of core**][**stretched over front face of edge-framed core and bonded or attached to edges and back of frame**]<**Insert description**>.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acoustical Panel Systems (APS, Inc.)**]
b. [**Acoustical Solutions**]
c. [**Armstrong Ceiling & Wall Solutions**]
d. [**Armstrong World Industries**]
e. [**AVL Systems, Inc**]
f. [**Benton Brothers Solutions, Inc.**]
g. [**Conwed**]
h. [**Decoustics; CertainTeed Architectural Products; a Saint Gobain company**]
i. [**Essi Acoustical Products**]
j. [**G&S Acoustics**]
k. [**Lamvin, Inc**]
l. [**MBI Products Company, Inc**]
m. [**Perdue Acoustics**]
n. [**Sound Concepts**]
o. [**Sound Management Group LLC**]
p. [**Wenger Corporation**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acoustical Panel Systems (APS, Inc.)**]
b. [**Acoustical Solutions**]
c. [**Armstrong Ceiling & Wall Solutions**]
d. [**Armstrong World Industries**]
e. [**AVL Systems, Inc**]
f. [**Benton Brothers Solutions, Inc.**]
g. [**Conwed**]
h. [**Decoustics; CertainTeed Architectural Products; a Saint Gobain company**]
i. [**Essi Acoustical Products**]
j. [**G&S Acoustics**]
k. [**Lamvin, Inc**]
l. [**MBI Products Company, Inc**]
m. [**Perdue Acoustics**]
n. [**Sound Concepts**]
o. [**Sound Management Group LLC**]
p. [**Wenger Corporation**]
q. <**Insert manufacturer's name**>

3. Panel Shape: [**Flat**][**As indicated on Drawings**]<**Insert shape**>.
4. Mounting: Back mounted with manufacturer's standard [**metal clips**][**suspension system**][**suspension system with stiffening, back-support angles**]<**Insert requirement**>, secured to substrate.
5. Core: [**Manufacturer's standard**][**Glass-fiber board**][**Glass-fiber blanket**][**Mineral-fiber**

board][Cementitious-fiber board][Medium-density fiberboard][Particleboard]<Insert requirement>.

6. Core Overlay: Polyester batting [1/2 inch (13 mm) thick][manufacturer's standard thickness]<Insert dimension>.
7. Edge Construction: Manufacturer's standard [chemically hardened core with no frame][extruded-aluminum or zinc-coated, rolled-steel frame][extruded PVC frame][wood frame, rabbeted, and splined with glued joints and machined corners]<Insert requirement>.
8. Edge Profile: [Chamfered (beveled)][Eased (small radius)][Mitered (beveled to a point)][Radiused (bullnosed)][Square][Custom profile as indicated on Drawings]<Insert profile>.
9. Corner Detail in Elevation: [Square][Round, radius as indicated on Drawings][Custom as indicated on Drawings]<Insert description> with continuous edge profile indicated.
10. Reveals between Panels: [Recessed][Flush][Projecting] reveals [as selected by Architect from manufacturer's full range][as indicated on Drawings]<Insert requirement>.
11. Facing Material: [Owner-furnished material][As indicated on Drawings]<Insert drawing designation>.
12. Nominal [Core][Overall Panel] Thickness: [3/4 inch (19 mm)][1 inch (25 mm)][1-1/2 inches (38 mm)][2 inches (51 mm)][As indicated on Drawings]<Insert dimension>.
13. Panel Width: [24 inches (610 mm)][30 inches (762 mm)][48 inches (1220 mm)][As indicated on Drawings]<Insert dimension>.
14. Panel Height: [72 inches (1829 mm)][96 inches (2438 mm)][108 inches (2743 mm)][120 inches (3048 mm)][As indicated on Drawings]<Insert dimension>.

2.4 MATERIALS

A. Composite Wood Products: Products shall be made without urea formaldehyde.

B. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

D. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:

1. Hardwood Plywood: 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. MDF More Than 5/16 Inch (8 mm) Thick: 0.11 ppm.
4. MDF 5/16 Inch (8 mm) or Less in Thickness: 0.13 ppm.

E. Composite Wood Products: Products shall be made without urea formaldehyde.

F. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.

G. Regional Materials: Products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

H. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site.

I. Regional Materials: Products shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

J. Indigenous Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

K. Regional Materials: Products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

L. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

M. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

N. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

O. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

P. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

Q. Core Materials:[**Manufacturer's standard.**]

1. Glass-Fiber Board: ASTM C612, of type standard with manufacturer; nominal density of [**6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**]<**Insert value**>, unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Glass-Fiber Blanket: ASTM C553, ASTM C612, or ASTM C665; of type standard with manufacturer; nominal density of [**3 to 4 lb/cu. ft. (48 to 64 kg/cu. m)**]<**Insert value**>; flexible; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
3. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of [**13-lb/cu. ft. (208-kg/cu. m)**][**20-lb/cu. ft. (320-kg/cu. m)**].
4. Cementitious-Fiber Board: Density of not less than [**20 lb/cu. ft. (320 kg/cu. m)**]<**Insert value**>.
5. Medium-Density Fiberboard: Panels complying with ANSI A208.2, [**grade to suit performance requirements**][**Grade 130**]<**Insert grade**>.

    a. Fire-retardant panels made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less when tested in accordance with ASTM E84 or UL 723.

6. Particleboard: Panels complying with ANSI A208.1, [**grade to suit performance requirements**][**Grade M-2**]<**Insert grade**>.

    a. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less when tested in accordance with ASTM E84 or UL 723.

7. Core Overlay: Flame-retardant, compressible, fiberfill, polyester batting.
8. Wood and Plywood: Manufacturer's standard plywood or clear, vertical grain, straight, kiln-dried hardwood.

    a. Fire-retardant treated by pressure process with a flame spread index of 25 or less when tested in accordance with ASTM E84 or UL 723, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet (3.2 m)** beyond the centerline of the burners at any time during the test.

        1) Treated material is to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity.
        2) Kiln-dry material after treatment to 19 percent or less for lumber and 15 percent or less for plywood.

R. Facing Material : Fabric from same dye lot; color and pattern [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**]<**Insert requirement**>.

1. Manufacturer: <**Insert manufacturer's name**>.
2. Product Line/Pattern: <**Insert product name or designation**>.
3. Pattern Repeat: <**Insert requirement**>.
4. Style Number: <**Insert number**>.
5. Color: <**Insert name or number, or both**>.
6. Fiber Content: [**100**]<**Insert number**> percent [**woven polyester**][**nonwoven polyester**][**polyolefin**][**vinyl**]<**Insert fiber requirement**>.
7. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**]<**Insert dimension**>.
8. Source: <**Insert fabric-vendor's name**>.
9. Applied Treatments: [**Stain resistance**][**flame-retardant**][**acrylic backing, single coat**][**acrylic backing, double coat**][**latex backing**][**foam backing**][**and**][**knit backing**]<**Insert treatment**>.
10. Light Reflectance: Average value not less than [**0.75**]<**Insert value**> when tested in accordance with ASTM E1477.
11. Lining Material: [**Manufacturer's standard fabric for each use indicated**]<**Insert material designation**>.

S. Lining Material <**Insert material designation**>: Fabric [**as indicated by manufacturer's designations**][**matching Architect's samples**][**as selected by Architect from manufacturer's full range**][**as indicated on Drawings**]<**Insert requirement**>.

1. Manufacturer: <**Insert manufacturer's name**>.
2. Product Line: <**Insert product name or designation**>.
3. Style Number: <**Insert number**>.
4. Color: [**White**]<**Insert name or number, or both**>.
5. Fiber Content: <**Insert content by percentage and fiber type**>.
6. Width: [**54 inches (1371 mm)**][**66 inches (1676 mm)**]<**Insert dimension**>.
7. Source: <**Insert fabric-vendor's name**>.
8. Applied Treatments: [**Stain resistance**][**and**][**flame retardant**]<**Insert treatment**>.

T. Mounting Devices: Concealed on back of panel, recommended by manufacturer to support weight of panel.

2.5 FABRICATION

A. Standard Construction: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

B. Measure each area and establish layout of panels and joints of [**uniform size with balanced borders at opposite edges**][**sizes indicated on Drawings**] within a given area.

C. Edge Hardening: For [**glass-fiber board**][**and**][**mineral-fiber board**] cores, chemically harden core edges and areas of core where mounting devices are attached.

D. Core Overlay: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

E. Facing Material[**and Lining Material**]: Apply fabric fully covering visible surfaces of panel; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. Square Corners: Tailor corners.[**Heat seal vinyl fabric seams at corners.**]
2. Radius and Other Nonsquare Corners: Attach material so there are no seams or gathering of material.
3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches adjacent panels.

F. Dimensional Tolerances of Finished Panels: Plus or minus **1/16 inch (1.6 mm)** for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated panels, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting panel performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panels in locations indicated. Unless otherwise indicated, install units with edges in alignment with walls and other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with panel manufacturer's written instructions for installation of panels using type of mounting devices indicated. Mount panels securely to supporting substrate.

C. Align fabric pattern and grain[**with adjacent panels**][**as shown on Drawings**].

3.3 INSTALLATION TOLERANCES

A. Variation from Alignment with Surfaces: Plus or minus [**1/16 inch (1.6 mm)**]<**Insert dimension**> in **48 inches (1200 mm)**, noncumulative.

B. Variation from Level or Slope: Plus or minus [**1/16 inch (1.6 mm)**][**1/8 inch (3.2 mm)**]<**Insert dimension**>.

C. Variation of Joint Width: Not more than [**1/16 inch (1.6 mm)**][**1/32 inch (0.79 mm)**]<**Insert dimension**> wide from [**hairline**][**reveal line**] in **48 inches (1200 mm)**, noncumulative.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 09 54 00 00A

Task	Specification	Specification Description
09 54 16 00	09 54 00 00	Stretched-Fabric Ceiling Systems
09 54 16 00	09 54 00 00a	Fabric-Wrapped Ceiling Panels

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SECTION 09 54 23 00 - LINEAR METAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Linear metal ceilings.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.5 COORDINATION

A. Coordinate layout and installation of linear metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. <**Insert participant requirements**>.

1.7 ACTION SUBMITTALS

A. Product Data: For linear metal ceilings.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting

materials.

C. Shop Drawings: For linear metal ceilings.

1. Include reflected ceiling plans, sections, and details, drawn to scale, showing the following:

a. Linear ceiling patterns and joints.
b. Ceiling suspension members.
c. Method of attaching hangers to building structure and locations of cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
d. Ceiling-mounted items including, but not limited to, light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
e. Ceiling perimeter and penetrations through ceiling; trim and moldings.

D. Samples: For each exposed product and for each type, color, and finish specified, **12 inches (305 mm)** long in size.

E. Samples for Initial Selection: For units with factory-applied colors and finishes.

1. Include Samples of accessories involving color and finish selections.

F. Samples for Verification: For the following products:

1. Linear Metal Pans: **12 inches (305 mm)** long by full-width Samples of each type, color, and finish and a **12-inch- (305-mm-)** long spliced section.
2. Suspension-System Members: **12-inch- (305-mm-)** long Sample of each type.
3. Exposed Molding and Trim: **12-inch- (305-mm-)** long Samples of each type, color, and finish.
4. Filler Strips: **12-inch- (305-mm-)** long Samples of each type, color, and finish.
5. Sound Absorbers: **12 inches (305 mm)** long by full width.
6. End Caps: Full size.

G. Delegated Design Submittals: For design of[**seismic restraints and**] attachment devices.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Test Reports: For each linear metal ceiling, for tests performed by a qualified testing agency.

C. Evaluation Reports: For linear-metal-ceiling framing systems.

D. Field quality-control reports.

1.9 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Linear-Metal-Ceiling Components: Quantity of each pan, carrier, accessory, and exposed molding and trim equal to [**2**]<**Insert number**> percent of quantity installed.

1.11 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by National Voluntary Laboratory Accreditation Program for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of each type of linear metal ceiling as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

D. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

F. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver ceiling components and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle ceiling components and accessories in a manner that prevents damage.

1.13 PROJECT CONDITIONS

A. Environmental Limitations: Do not install interior ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements" to design [**seismic restraints and**]attachment devices.

B. Structural Performance: Exterior linear metal ceilings to withstand exterior exposure, the effects of gravity loads, and the following loads and stresses without showing permanent deformation of ceiling system components, including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling pans; or permanent damage to fasteners and anchors:

1. Wind Load: Uniform pressure [**indicated on Drawings**]<**Insert requirements**>, acting inward or outward.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C) material surfaces**]<**Insert requirements**>.

D. Seismic Criteria: Provide linear metal ceilings designed and installed to withstand the effects of earthquake motions in accordance with [**ASTM E580/E580M**][**CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2"**][**CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4"**][**ASCE/SEI 7**]<**Insert requirements**> and requirements of authorities having jurisdiction.

E. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**]<**Insert value**> percent.

2.2 LINEAR METAL CEILINGS

A. Pans and Suspension System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Decorative Ceilings, Inc.**]
b. [**Armstrong Ceiling & Wall Solutions**]
c. [**B+N Industries, Inc.**]
d. [**Rockfon; ROCKWOOL International**]
e. [**USG Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Decorative Ceilings, Inc.**]
b. [**Armstrong Ceiling & Wall Solutions**]
c. [**B+N Industries, Inc.**]
d. [**Rockfon; ROCKWOOL International**]
e. [**USG Corporation**]
f. <**Insert manufacturer's name**>

B. Metal Pans: Complying with ASTM E1264 for [**Type XIII**][**Type XX**] and formed to snap on to carriers securely, without separate fasteners.

1. Surface-Burning Characteristics: For metal-pan assemblies, including backings, determined by testing in accordance with ASTM E84 by a qualified testing agency. Identify products with

appropriate markings of applicable testing agency.

a. Flame-Spread Index: [**25**]<**Insert value**> or less.
b. Smoke-Developed Index: [**50**][**55**]<**Insert value**> or less.

2. Metal: [**Aluminum sheet, ASTM B209 (ASTM B209M), alloy and temper recommended by producer and finisher for type of use and finish indicated**][**Electrolytic zinc-coated steel sheet, ASTM A879/A879M, 04Z (12G) coating; surface treatment as recommended by finish manufacturer for type of use and painted finish indicated**]<**Insert requirements**>.
3. Form: [**Perforated**][**Nonperforated**].

a. Perforation Pattern: [**As indicated by manufacturers designation**]<**Insert requirements**>.

4. Noise Reduction Coefficient (NRC) Rating: Not less than [**0.70**][**0.75**][**0.85**][**1.00**]<**Insert requirements**> when tested in accordance with ASTM C423.
5. Backing: [**Manufacturer's standard to provide NRC rating indicated for perforation pattern indicated**][**Nonwoven black fabric**][**Nonwoven black fabric with 1-inch- (25-mm-) thick glass fiber, 1 lb/cu. ft. (16 kg/cu. m) density, enclosed in black polyethylene**][**1-inch- (25-mm-) thick glass fiber, 1 lb/cu. ft. (16 kg/cu. m) density, enclosed in black polyethylene**]<**Insert requirements**>.
6. Pan Thickness: Not less than [**0.020 inch (0.51 mm)**][**0.025 inch (0.64 mm)**][**0.028 inch (0.71 mm)**][**0.040 inch (1.02 mm)**]<**Insert dimension**>.
7. Pan Edge Detail: [**Beveled**][**Square**][**Round**][**Manufacturer's standard**].
8. Pan Width: [**2-inch (51-mm) module width and 1-1/4-inch (32-mm) face width**][**4-inch (102-mm) module width and 3-1/4-inch (83-mm) face width**][**6-inch (152-mm) module width and 5-1/4-inch (133-mm) face width**][**8-inch (203-mm) module width and 7-1/4-inch (184-mm) face width**][**As indicated on Drawings**]<**Insert dimensions**>.
9. Pan Depth: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**][**1-1/2 inches (38 mm)**][**As indicated on Drawings**]<**Insert dimension**>.
10. Metal-Pan Finish: Protected on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping and as follows:

a. Aluminum Anodic Finish: [**Clear finish, AAMA 611, AMP 500 AA-M12C22A31, Class II, 0.010 mm or thicker**][**Clear, mirror finish, AMP 500 AA-M21C12A212, 0.005 mm or thicker**]<**Insert requirements**>.
b. Color-Coated Finish: Manufacturer's standard[**powder-coat**] baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

1) Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match Architect's sample**][**As indicated by manufacturer's product designation**]<**Insert requirements**>.
2) Light Reflectance (LR) Coefficient: Not less than [**0.61**][**0.77**][**0.81**]<**Insert value**> LR when tested in accordance with ASTM E1477.

c. Laminated-Film Finish: Provide [**manufacturer's standard**][**vinyl**][**PVC-free**]<**Insert requirements**> film permanently bonded to metal pan with adhesive.

1) Color and Pattern: [**As selected by Architect from manufacturer's full range**][**Match Architect's sample**][**As indicated by manufacturer's product designation**]<**Insert requirements**>.

d. Wood-Veneer Finish: [**Match Architect's sample**][**As indicated by manufacturer's product designation**][**Wood veneer in species and finish selected by Architect from manufacturer's full range**]<**Insert requirements**>; permanently bonded to metal pan with

adhesive.

e. Finish Bonding Adhesive: Manufacturer's standard that permanently bonds finish to aluminum.

C. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-00 and FSC STD-40-004.

D. Certified Wood: Wood products shall be certified as "FSC Pure"[**or "FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.

E. Certified Wood: Wood products shall be labeled according to the AFPA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

F. Certified Wood: Wood products shall [**contain not less than 60 percent**][**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

G. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AFPA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

H. Adhesives: Do not use adhesives that contain urea formaldehyde.

I. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

J. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

K. Adhesives: Do not use adhesives that contain urea formaldehyde.

L. Adhesives: Do not use adhesives that contain urea formaldehyde.

M. Pan Splices: Formed for snap fit into butt-cut pans, [**4 inches (102 mm)**][**8 to 12 inches (203 to 305 mm)**]<**Insert dimension**> long.

1. Finish: [**Manufacturer's standard**][**Matte black**][**Matching pan**]<**Insert requirements**>.

N. End Caps: Manufacturer's standard material fabricated to fit and conceal exposed ends of pans.

1. Finish: [**Manufacturer's standard**][**Matte black**][**Matching pan**]<**Insert requirements**>.

O. Filler Strips: Manufacturer's standard, fabricated to close voids between pans.

1. Type: [**Recessed**][**Flush**][**Integral extension of pan profile**][**Expansion, for use with expansion carriers**][**Slotted, for air diffusion**]<**Insert requirements**>.
2. Finish: [**Manufacturer's standard**][**Matte black**][**Matching pan**]<**Insert requirements**>.

P. Moldings and Trim: Manufacturer's standard for exposed members, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at

changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.

1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

Q. Carrier Suspension System: Manufacturer's standard complying with requirements in ASTM C635/C635M for applications indicated; complete with carriers, splice sections, stabilizing components, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.

1. Material: [**ASTM A653/A653M, hot-dip galvanized, cold-rolled sheet steel, G60 (Z180) coating designation**][**ASTM A879/A879M, electrolytic zinc-coated, cold-rolled steel, 08Z (24G) coating designation**][**ASTM B209 (ASTM B209M) aluminum**]<**Insert requirements**>.
2. Structural Classification: [**Heavy-duty**]<**Insert requirements**> system.
3. Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.
4. Flexible Radial Carriers: Manufacturer's standard radial carriers.
5. Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.
6. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers.
7. Carrier Splices: Same metal, profile, and finish as for carriers.
8. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.
9. Carrier Finish: [**Flat black**]<**Insert requirements**>.

2.3 CARRIER-SYSTEM HANGERS, BRACES, AND TIES

A. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.

1. Cast-in-Place and Postinstalled Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to [**5**]<**Insert safety factor**> times that imposed by ceiling construction as determined by testing in accordance with ASTM E488/E488M or ASTM E1512, as applicable, conducted by a qualified testing and inspecting agency.

   a. Type: [**Cast-in-place**][**Postinstalled expansion**][**Postinstalled bonded**] anchors.
   b. Corrosion Protection:

      1) Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
      2) Stainless steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
      3) Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to [**10**]<**Insert safety factor**> times that imposed by ceiling construction as determined by testing in accordance with ASTM E1190 conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung is less than yield stress of wire, but provides not less than [**0.106-inch- (2.69-mm-)**][**0.135-inch- (3.5-mm-)**]<**Insert dimension**> diameter wire.

C. Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed from **0.04-inch- (1.0-mm-)** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

E. Seismic Struts: Suspension-system manufacturer's standard compression struts designed to accommodate seismic forces.

F. Exterior Bracing: Cold-rolled steel channels and angles, hot-dip galvanized to comply with ASTM A653/A653M, **G60 (Z180)** coating designation; size and profile as required to withstand wind load.

2.4 ACCESSORIES

A. Access Panels: For access at locations indicated, provide door hinge assembly, retainer clip, and retainer bar, assembled with ceiling panels and carrier sections into access doors permitting upward or downward opening.

1. Size: [**As indicated on Drawings**][**24 inches (610 mm) square**]<**Insert requirements**>.

B. Air-Distribution Devices: Where indicated on Drawings, provide independently suspended air-distribution devices that are relocatable and adjustable from below finished ceiling, that do not interrupt ceiling components, and that are fully concealed by and integrated with ceiling system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of linear metal pans.

1. Balance border widths at opposite edges of each ceiling.
2. Avoid using less-than-half-width pans at borders.

3.3 INSTALLATION OF LINEAR METAL CEILINGS

A. Comply with ASTM C636/C636M and seismic requirement indicated, in accordance with manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns in **3 inches (76 mm)**. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts**[, power-actuated fasteners,]** or postinstalled mechanical or adhesive anchors that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than **48 inches (1219 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (203 mm)** from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns in **1-1/2 inches (38 mm)**. Suspend bracing from building's structural members as required for hangers and without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.

1. Screw attach moldings to substrate at intervals of not more than **16 inches (406 mm)** o.c. and not more than **3 inches (76 mm)** from ends, leveling with ceiling suspension system to a tolerance of **1/8 inch in 12 feet (3 mm in 3.7 m)**. Miter corners accurately and connect securely.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system carriers so they are aligned and securely interlocked with one another.

1. Install stabilizer channels, tees, and bars at regular intervals to stabilize carriers and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated.
2. Remove and replace dented, bent, or kinked members.

F. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness.

G. Install linear metal pans in coordination with suspension system and exposed moldings and trim.

1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated on Drawings.
2. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.

a. Install pans with butt joints [**aligned**][**aligned, every other pan length**][**staggered a minimum of 12 inches (305 mm)**][**randomly aligned**][**aligned as indicated on Drawings**]<**Insert requirements**> using internal pan splices.

3. Install directionally textured or patterned metal pans in directions indicated.
4. Where metal pan ends are visible, install end caps unless trim is indicated.
5. Install filler strips where indicated [**on Drawings**]<**Insert requirements**>.
6. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.

H. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Suspended ceiling system.
2. Hangers, anchors, and fasteners.
3. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections: Testing and inspecting of completed installations of linear metal ceiling hangers, anchors, and fasteners to take place in successive stages, in test areas and using methods as follows. Do not proceed with installations of linear metal ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.

1. Test Areas: Test installation of ceiling suspension systems on each floor when installation has reached 20 percent completion but before pans have been installed.

a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for **200 lbf (890 N)** of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for **440 lbf (1957 N)** of tension.
b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Linear metal ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings, after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 09 54 23 00

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Task	Specification	Specification Description
09 54 23 00	09 51 33 00	Acoustical Metal Pan Ceilings
09 54 23 00	09 54 00 00	Stretched-Fabric Ceiling Systems
09 54 23 00	09 54 00 00a	Fabric-Wrapped Ceiling Panels
09 84 13 00	09 29 00 00	Gypsum Board

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SECTION 09 91 13 00 - EXTERIOR PAINTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for exterior painting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
   a. Concrete.
   b. Clay masonry.
   c. Concrete masonry units (CMU).
   d. Steel.
   e. Galvanized metal.
   f. Aluminum (not anodized or otherwise coated).
   g. Wood.
   h. Plastic trim fabrications.
   i. Exterior portland cement (stucco).
   j. Exterior gypsum board.

C. Submittals
1. Product Data: For each type of product indicated. Provide data on all finishing products, including VOC content.
2. Samples: For each finish and for each color and texture required. Submit two painted samples, illustrating selected colors and textures for each color and system selected. Submit on tempered hardboard, 8 x 10 inch in size.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.

D. Quality Assurance
1. MPI Standards:
   a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated. For renovation projects, comply with requirements of "MPI Maintenance Repainting Manual" for products and paint systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
3. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.2 PRODUCTS

A. Paint, General
1. Conform to applicable code for flame and smoke rating requirements for products and finishes.
2. Conform to County of San Mateo Public Works Building Standards
   a. Paint products shall not contain formaldehyde, aqueous ammonia, crystalline silica, or ethylene glycol. Total Volatile Organic Compounds (VOC) shall not exceed 2.9 pounds per gallon.
3. Material Compatibility:
   a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
4. Colors: As selected from manufacturer's full range.

B. Block Fillers
1. Interior/Exterior Latex Block Filler: MPI #4.
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.

C. Primers/Sealers
1. Alkali-Resistant Primer: MPI #3.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Bonding Primer (Water Based): MPI #17.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Bonding Primer (Solvent Based): MPI #69.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint system indicated.

D. Metal Primers
1. Alkyd Anticorrosive Metal Primer: MPI #79.
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Quick-Drying Alkyd Metal Primer: MPI #76.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Cementitious Galvanized-Metal Primer: MPI #26.
   a. VOC Content: E Range of E1.
4. Waterborne Galvanized-Metal Primer: MPI #134.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
5. Quick-Drying Primer for Aluminum: MPI #95.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

E. Wood Primers
1. Exterior Latex Wood Primer: MPI #6.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Exterior Alkyd Wood Primer: MPI #5.
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
3. Exterior Oil Wood Primer: MPI #7.
   a. VOC Content: E Range of E2.

F. Exterior Latex Paints
1. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).

a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

3. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Exterior Alkyd Paints
1. Exterior Alkyd Enamel (Flat): MPI #8 (Gloss Level 1).
   a. VOC Content: E Range of E1.
2. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Exterior Alkyd Enamel (Gloss): MPI #9 (Gloss Level 6).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.

H. Quick-Drying Enamels
1. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
   a. VOC Content: E Range of E1 **OR** E **OR** E3, **as directed**.

I. Textured And High-Build Coatings
1. Latex Stucco and Masonry Textured Coating: MPI #42.
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
2. High-Build Latex (Exterior): MPI #40.
   a. VOC Content: E Range of E1 **OR** E3, **as directed**.

J. Aluminum Paint
1. Aluminum Paint: MPI #1.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

K. Floor Coatings
1. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Interior/Exterior Latex Floor and Porch Paint (Low Gloss): MPI #60 (maximum Gloss Level 3).
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 3.
4. Exterior/Interior Alkyd Floor Enamel (Gloss): MPI #27 (Gloss Level 6).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
   b. Additives: Manufacturer's standard additive to increase skid resistance of painted surface.

L. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
2. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   a. Concrete: 12 percent.
   b. Masonry (Clay and CMU): 12 percent.
   c. Wood: 15 percent.
   d. Plaster: 12 percent.
   e. Gypsum Board: 12 percent.

3. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
4. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
   a. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

B. Preparation And Application
1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
2. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   a. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
3. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
4. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
5. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
6. Marks: Seal with shellac those which may bleed through surface finishes.
7. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

C. Exterior Painting Schedule
1. Paint systems herein are based on "MPI Architectural Painting Specification Manual" (hereafter, "MPI Manual"). For renovation projects, consult "MPI Maintenance Repainting Manual" and revise paint systems accordingly.
2. For a Premium Grade system, "MPI Manual" requires intermediate coat; if Custom Grade system is required or if so directed, delete intermediate coat, **unless directed otherwise** or as otherwise required by manufacturer's recommendations.
3. Concrete Substrates, Nontraffic Surfaces:
   a. Latex System: MPI EXT 3.1A.
      1) Prime Coat: Exterior latex matching topcoat.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Aggregate/Latex System: MPI EXT 3.1 B.
      1) Prime Coat: Latex stucco and masonry textured coating.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Latex Over Alkali-Resistant Primer System: MPI EXT 3.1K.
      1) Prime Coat: Alkali-resistant primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. High-Build Latex System: MPI EXT 3.1L, applied to form dry film thickness of not less than 10 mils (0.25 mm).
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: High-build latex (exterior).
   e. Latex Aggregate System: MPI EXT 3.1N.
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: Latex stucco and masonry textured coating.

4. Concrete Substrates, Traffic Surfaces:
   a. Latex Floor Paint System: MPI EXT 3.2A.
      1) Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
      2) Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
      3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).
   b. Alkyd Floor Enamel System: MPI EXT 3.2D.
      1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
      2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
      3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
   c. Clear Sealer System: MPI EXT 3.2G.
      1) Prime Coat: Interior/exterior clear concrete floor sealer (solvent based).
      2) Intermediate Coat: Interior/exterior clear concrete floor sealer (solvent based).
      3) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).
   d. Water-Based Clear Sealer System: MPI EXT 3.2H.
      1) Prime Coat: Interior/exterior clear concrete floor sealer (water based).
      2) Intermediate Coat: Interior/exterior clear concrete floor sealer (water based).
      3) Topcoat: Interior/exterior clear concrete floor sealer (water based).
5. Clay-Masonry Substrates:
   a. Latex System: MPI EXT 4.1A.
      1) Prime Coat: Exterior latex matching topcoat.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. High-Build Latex System: MPI EXT 4.1H, applied to form dry film thickness of not less than 10 mils (0.25 mm).
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: High-build latex (exterior).
   c. Latex Aggregate System: MPI EXT 4.1B.
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: Latex stucco and masonry textured coating.
6. CMU Substrates:
   a. Latex System: MPI EXT 4.2A.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Alkali-Resistant Primer System: MPI EXT 4.2L.
      1) Prime Coat: Alkali-resistant primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. High-Build Latex System: MPI EXT 4.2K, applied to form dry film thickness of not less than 10 mils (0.25 mm).
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: High-build latex (exterior).
   d. Latex Aggregate System: MPI EXT 4.2B.
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: Latex stucco and masonry textured coating.
7. Steel Substrates:
   a. Quick-Drying Enamel System: MPI EXT 5.1A.
      1) Prime Coat: Quick-drying alkyd metal primer.
      2) Intermediate Coat: Quick-drying enamel matching topcoat.
      3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.
   b. Alkyd System: MPI EXT 5.1D.
      1) Prime Coat: Alkyd anticorrosive metal primer.

2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Aluminum Paint System: MPI EXT 5.1K.
1) Prime Coat: Alkyd anticorrosive metal primer.
2) Intermediate Coat: Aluminum paint.
3) Topcoat: Aluminum paint.

8. Galvanized-Metal Substrates: Galvanized-metal substrates should not be chromate passivated (commercially known as "bonderized") if primer is field applied. If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.
a. Latex System: MPI EXT 5.3A.
1) Prime Coat: Cementitious galvanized-metal primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Water-Based Primer System: MPI EXT 5.3H. "MPI Manual" recommends latex over water-based primer system for low-contact/traffic areas.
1) Prime Coat: Waterborne galvanized-metal primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI EXT 5.3B.
1) Prime Coat: Cementitious galvanized-metal primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

9. Aluminum Substrates:
a. Latex System: MPI EXT 5.4H.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd System: MPI EXT 5.4F.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

10. Glue-Laminated Beam and Column Substrates:
a. Latex System: MPI EXT 6.1L.
1) Prime Coat: Exterior latex wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI EXT 6.1A.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI EXT 6.1B.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

11. Dressed Lumber Substrates: Including architectural woodwork **OR** doors, **as directed**.
a. Latex System: MPI EXT 6.3L.
1) Prime Coat: Exterior latex wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.

b. Latex Over Alkyd Primer System: MPI EXT 6.3A.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.

c. Alkyd System: MPI EXT 6.3B.
   1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
   2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
   3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.

12. Wood Panel Substrates: Including plywood siding **OR** fascias **OR** soffits, **as directed**.
   a. Latex System: MPI EXT 6.4K.
      1) Prime Coat: Exterior latex wood primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Alkyd Primer System: MPI EXT 6.4G.
      1) Prime Coat: Exterior alkyd wood primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd System: MPI EXT 6.4B.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
      2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
      3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
13. Wood Shingle and Shake Substrates (Excluding Roofs):
   a. Latex System: MPI EXT 6.6E.
      1) Prime Coat: Exterior latex wood primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Alkyd Primer System: MPI EXT 6.6A.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd System: MPI EXT 6.6B.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
      2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
      3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
14. Dimension Lumber Substrates, Nontraffic Surfaces: Including board siding **OR** fencing **OR** undersides of decking, **as directed**.
   a. Latex System: MPI EXT 6.2M.
      1) Prime Coat: Exterior latex wood primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Alkyd Primer System: MPI EXT 6.2A.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd System: MPI EXT 6.2C.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
      2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
      3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
15. Dimension Lumber Substrates, Traffic Surfaces: Including lumber decking **OR** stairs, **as directed**.
   a. Latex System: MPI EXT 6.5E.
      1) Prime Coat: Exterior latex wood primer.
      2) Intermediate Coat: Interior/exterior latex floor and porch (low gloss).
      3) Topcoat: Interior/exterior latex floor and porch (low gloss).
         a) With additive to increase skid resistance of painted surface.
   b. Latex Over Alkyd Primer System: MPI EXT 6.5A.
      1) Prime Coat: Exterior alkyd wood primer.
      2) Intermediate Coat: Interior/exterior latex floor and porch (low gloss).
      3) Topcoat: Interior/exterior latex floor and porch (low gloss).

a) With additive to increase skid resistance of painted surface.

c. Alkyd Floor Enamel System: MPI EXT 6.5B.
1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
a) With additive to increase skid resistance of painted surface.

16. Plastic Trim Fabrication Substrates:
a. Latex System: MPI EXT 6.8A.
1) Prime Coat: Bonding primer (water based) **OR** (solvent based), **as directed**.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
b. Alkyd System: MPI EXT 6.8B.
1) Prime Coat: Bonding primer (water based) **OR** (solvent based , **as directed**.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

17. Stucco Substrates:
a. Latex System: MPI EXT 9.1A.
1) Prime Coat: Exterior latex matching topcoat.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
b. Latex Over Alkali-Resistant Primer System: MPI EXT 9.1J.
1) Prime Coat: Alkali-resistant primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
c. High-Build Latex System: MPI EXT 9.1H, applied to form dry film thickness of not less than 10 mils (0.25 mm).
1) Prime Coat: As recommended in writing by topcoat manufacturer.
2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: High-build latex (exterior).

18. Exterior Gypsum Board Substrates:
a. Latex System: MPI EXT 9.2A.
1) Prime Coat: Exterior latex matching topcoat.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

END OF SECTION 09 91 13 00

Task	Specification	Specification Description
09 91 13 00	01 22 00 00	No Specification Required
09 91 13 00	09 93 00 00	Staining and Transparent Finishing

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SECTION 09 91 23 00 - INTERIOR PAINTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for interior painting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and the application of paint systems on the following interior substrates:
   a. Concrete.
   b. Clay masonry.
   c. Concrete masonry units (CMU).
   d. Steel.
   e. Galvanized metal.
   f. Aluminum (not anodized or otherwise coated).
   g. Wood.
   h. Gypsum board.
   i. Plaster.
   j. Spray-textured ceilings.
   k. Cotton or canvas insulation covering.

C. Submittals
1. Product Data: For each type of product indicated. Provide data on all finishing products, including VOC content.
2. Samples: For each finish and for each color and texture required. Submit two painted samples, illustrating selected colors and textures for each color and system selected. Submit on tempered hardboard, 8 x 10 inch in size.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.
4. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For paints, including printed statement of VOC content and chemical components.

D. Quality Assurance
1. MPI Standards:
   a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

2. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
3. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.2 PRODUCTS

A. Paint, General
1. Conform to applicable code for flame and smoke rating requirements for products and finishes.
2. Conform to County of San Mateo Public Works Building Standards
   a. Paint products shall not contain formaldehyde, aqueous ammonia, crystalline silica, or ethylene glycol. Total Volatile Organic Compounds (VOC) shall not exceed 2.9 pounds per gallon.
3. Material Compatibility:
   a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
4. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
   b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
   c. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
   d. Floor Coatings: VOC not more than 100 g/L.
   e. Shellacs, Clear: VOC not more than 730 g/L.
   f. Shellacs, Pigmented: VOC not more than 550 g/L.
   g. Flat Topcoat Paints: VOC content of not more than 50 g/L.
   h. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
   i. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
   j. Floor Coatings: VOC not more than 100 g/L.
   k. Shellacs, Clear: VOC not more than 730 g/L.
   l. Shellacs, Pigmented: VOC not more than 550 g/L.
   m. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
   n. Dry-Fog Coatings: VOC content of not more than 400 g/L.
   o. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.
5. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.
6. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
   b. Restricted Components: Paints and coatings shall not contain any of the following:
      1) Acrolein.
      2) Acrylonitrile.
      3) Antimony.
      4) Benzene.
      5) Butyl benzyl phthalate.
      6) Cadmium.

7) Di (2-ethylhexyl) phthalate.
8) Di-n-butyl phthalate.
9) Di-n-octyl phthalate.
10) 1,2-dichlorobenzene.
11) Diethyl phthalate.
12) Dimethyl phthalate.
13) Ethylbenzene.
14) Formaldehyde.
15) Hexavalent chromium.
16) Isophorone.
17) Lead.
18) Mercury.
19) Methyl ethyl ketone.
20) Methyl isobutyl ketone.
21) Methylene chloride.
22) Naphthalene.
23) Toluene (methylbenzene).
24) 1,1,1-trichloroethane.
25) Vinyl chloride.

7. Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in a color schedule, **as directed**.

B. Block Fillers
1. Interior/Exterior Latex Block Filler: MPI #4.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.

C. Primers/Sealers
1. Interior Latex Primer/Sealer: MPI #50.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
2. Interior Alkyd Primer/Sealer: MPI #45.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

D. Metal Primers
1. Alkyd Anticorrosive Metal Primer: MPI #79.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Quick-Drying Alkyd Metal Primer: MPI #76.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Rust-Inhibitive Primer (Water Based): MPI #107.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Cementitious Galvanized-Metal Primer: MPI #26.
a. VOC Content: E Range of E1.
5. Waterborne Galvanized-Metal Primer: MPI #134.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
6. Vinyl Wash Primer: MPI #80.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.
7. Quick-Drying Primer for Aluminum: MPI #95.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

E. Wood Primers
1. Interior Latex-Based Wood Primer: MPI #39.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.

F. Latex Paints
1. Interior Latex (Flat): MPI #53 (Gloss Level 1).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 0.5 **OR** EPR 1.5 **OR** EPR 2.5, **as directed**.
2. Interior Latex (Low Sheen): MPI #44 (Gloss Level 2).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Interior Latex (Satin): MPI #43 (Gloss Level 4).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1.5 **OR** EPR 2 **OR** EPR 2.5 **OR** EPR 3.5, **as directed**.
5. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 2 **OR** EPR 3 **OR** EPR 4, **as directed**.
6. Interior Latex (Gloss): MPI #114 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 2 **OR** EPR 3 **OR** EPR 4, **as directed**.
7. Institutional Low-Odor/VOC Latex (Flat): MPI #143 (Gloss Level 1).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4 **OR** EPR 5.5, **as directed**.
8. Institutional Low-Odor/VOC Latex (Low Sheen): MPI #144 (Gloss Level 2).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4.5.
9. Institutional Low-Odor/VOC Latex (Eggshell): MPI #145 (Gloss Level 3).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4.5.
10. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 3 **OR** EPR 5.5, **as directed**.
11. High-Performance Architectural Latex (Low Sheen): MPI #138 (Gloss Level 2).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 4 **OR** EPR 5 **OR** EPR 6, **as directed**.
12. High-Performance Architectural Latex (Eggshell): MPI #139 (Gloss Level 3).
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 5 **OR** EPR 6, **as directed**.
13. High-Performance Architectural Latex (Satin): MPI #140 (Gloss Level 4).
   a. VOC Content: E Range of E1 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 4.5 **OR** EPR 6.5, **as directed**.
14. High-Performance Architectural Latex (Semigloss): MPI #141 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 5 **OR** EPR 6 **OR** EPR 7, **as directed**.
15. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
16. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
17. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Alkyd Paints
1. Interior Alkyd (Flat): MPI #49 (Gloss Level 1).

a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

2. Interior Alkyd (Eggshell): MPI #51 (Gloss Level 3).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Interior Alkyd (Semigloss): MPI #47 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Interior Alkyd (Gloss): MPI #48 (Gloss Level 6).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.

H. Quick-Drying Enamels
1. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

I. Textured Coating
1. Latex Stucco and Masonry Textured Coating: MPI #42.
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.

J. Dry Fog/Fall Coatings
1. Latex Dry Fog/Fall: MPI #118.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
2. Waterborne Dry Fall: MPI #133.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Interior Alkyd Dry Fog/Fall: MPI #55.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

K. Aluminum Paint
1. Aluminum Paint: MPI #1.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

L. Floor Coatings
1. Interior Concrete Floor Stain: MPI #58.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 2.
2. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
4. Interior/Exterior Latex Floor and Porch Paint (Low Gloss): MPI #60 (maximum Gloss Level 3).
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 3.
5. Exterior/Interior Alkyd Floor Enamel (Gloss): MPI #27 (Gloss Level 6).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
   b. Additives: Manufacturer's standard additive to increase skid resistance of painted surface.

M. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
    a. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
    b. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
3. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
    a. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content of surfaces or alkalinity of mortar joints to be painted exceed that permitted in manufacturer's written instructions.
6. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
7. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
8. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
9. Aluminum Substrates: Remove surface oxidation.
10. Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.
11. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
12. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.
13. Wood Substrates:
    a. Scrape and clean knots, and apply coat of knot sealer before applying primer.
    b. Sand surfaces that will be exposed to view, and dust off.
    c. Prime edges, ends, faces, undersides, and backsides of wood.
    d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
14. Gypsum Board Substrates: Fill minor defects with filler compound. Spot prime defects after repair. Do not begin paint application until finishing compound is dry and sanded smooth.
15. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
16. Spray-Textured Ceiling Substrates: Do not begin paint application until surfaces are dry.
17. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.
18. Marks: Seal with shellac those which may bleed through surface finishes.
19. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

B. Application
1. Apply paints according to manufacturer's written instructions.
    a. Use applicators and techniques suited for paint and substrate indicated.

b. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
c. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

2. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
3. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
4. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
5. Painting Mechanical and Electrical Work:
   a. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
   b. Finish equipment, piping, conduit, and exposed duct work at all exterior areas in colors according to the color schedule.
   c. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
   d. Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
      1) Mechanical Work:
         a) Uninsulated metal piping.
         b) Uninsulated plastic piping.
         c) Pipe hangers and supports.
         d) Tanks that do not have factory-applied final finishes.
         e) Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
         f) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
         g) Mechanical equipment that is indicated to have a factory-primed finish for field painting.
      2) Electrical Work:
         a) Switchgear.
         b) Panelboards.
         c) Electrical equipment that is indicated to have a factory-primed finish for field painting.

C. Field Quality Control
1. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
   a. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance with product requirements.
   c. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

2. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

E. Interior Painting Schedule
1. Concrete Substrates, Nontraffic Surfaces:
   a. Latex System: MPI INT 3.1E.
      1) Prime Coat: Interior latex matching topcoat.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Sealer System: MPI INT 3.1A.
      1) Prime Coat: Interior latex primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Latex Over Latex Aggregate System: MPI INT 3.1B.
      1) Prime Coat: Latex stucco and masonry textured coating.
      2) Intermediate Coat (for MPI Premium Grade system): Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Alkyd System: MPI INT 3.1D.
      1) Prime Coat: Interior latex primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   e. Institutional Low-Odor/VOC Latex System: MPI INT 3.1M.
      1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
      2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
      3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
   f. High-Performance Architectural Latex System: MPI INT 3.1C.
      1) Prime Coat: Interior latex primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
      3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
2. Concrete Substrates, Traffic Surfaces:
   a. Latex Floor Enamel System: MPI INT 3.2A.
      1) Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
      2) Intermediate Coat (for MPI Premium Grade system): Interior/exterior latex floor and porch paint (low gloss).
      3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).
   b. Alkyd Floor Enamel System: MPI INT 3.2B.
      1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
      2) Intermediate Coat (for MPI Premium Grade system): Exterior/interior alkyd floor enamel (gloss).
      3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
   c. Concrete Stain System: MPI INT 3.2E.
      1) First Coat (for MPI Premium Grade system): Interior concrete floor stain.

2) Topcoat: Interior concrete floor stain.

d. Clear Sealer System: MPI INT 3.2F.
   1) First Coat: Interior/exterior clear concrete floor sealer (solvent based).
   2) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).

e. Water-Based Clear Sealer System: MPI INT 3.2G.
   1) First Coat: Interior/exterior clear concrete floor sealer (water based).
   2) Topcoat: Interior/exterior clear concrete floor sealer (water based).

3. Clay-Masonry Substrates:
   a. Latex System: MPI INT 4.1A.
      1) Prime Coat: Interior latex matching topcoat.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Alkyd System: MPI INT 4.1D.
      1) Prime Coat: Interior latex primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Latex Aggregate System: MPI INT 4.1B.
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: Latex stucco and masonry textured coating.
   d. Institutional Low-Odor/VOC Latex System: MPI INT 4.1M.
      1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
      2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
      3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
   e. High-Performance Architectural Latex System: MPI INT 4.1L.
      1) Prime Coat: High-performance architectural latex matching topcoat.
      2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
      3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

4. CMU Substrates:
   a. Latex System: MPI INT 4.2A.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Alkyd System: MPI INT 4.2C.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd Over Latex Sealer System: MPI INT 4.2N.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Sealer Coat: Interior latex primer/sealer.
      3) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      4) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.

3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 4.2D.
1) Prime Coat: Interior/exterior latex block filler.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

5. Steel Substrates:
a. Quick-Drying Enamel System: MPI INT 5.1A.
1) Prime Coat: Quick-drying alkyd metal primer.
2) Intermediate Coat: Quick-drying enamel matching topcoat.
3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.

b. Water-Based Dry-Fall System: MPI INT 5.1C.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Topcoat: Latex dry fog/fall **OR** Waterborne dry fall, **as directed**.

c. Alkyd Dry-Fall System: MPI INT 5.1D.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Topcoat: Interior alkyd dry fog/fall.

d. Latex Over Alkyd Primer System: MPI INT 5.1Q.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

e. Alkyd System: MPI INT 5.1E.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

f. Aluminum Paint System: MPI INT 5.1M.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
3) Topcoat: Aluminum paint.

g. Institutional Low-Odor/VOC Latex System: MPI INT 5.1S.
1) Prime Coat: Rust-inhibitive primer (water based).
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

h. High-Performance Architectural Latex System: MPI INT 5.1R.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

6. Galvanized-Metal Substrates:
a. Water-Based Dry-Fall System: MPI INT 5.3H.
1) Prime Coat: Waterborne dry fall.
2) Topcoat: Waterborne dry fall.

b. Alkyd Dry-Fall System: MPI INT 5.3F.
1) Prime Coat: Cementitious galvanized-metal primer.
2) Topcoat: Interior alkyd dry fog/fall.

c. Latex System: MPI INT 5.3A.
1) Prime Coat: Cementitious galvanized-metal primer.
2) Intermediate Coat: Interior latex matching topcoat.

3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Latex Over Waterborne Primer System: MPI INT 5.3J.
1) Prime Coat: Waterborne galvanized-metal primer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

e. Alkyd System: MPI INT 5.3C.
1) Prime Coat: Cementitious galvanized-metal primer.
2) Intermediate Coat: Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

f. Aluminum Paint System: MPI INT 5.3G.
1) Prime Coat: Cementitious galvanized-metal primer.
2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
3) Topcoat: Aluminum paint.

g. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N.
1) Prime Coat: Waterborne galvanized-metal primer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

h. High-Performance Architectural Latex System: MPI INT 5.3M.
1) Prime Coat: Waterborne galvanized-metal primer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

7. Aluminum (Not Anodized or Otherwise Coated) Substrates:

a. Latex System: MPI INT 5.4H.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Over Vinyl Wash Primer System: MPI INT 5.4A.
1) Prime Coat: Vinyl wash primer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd Over Quick-Drying Primer System: MPI INT 5.4J.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Aluminum Paint System: MPI INT 5.4D.
1) Prime Coat: Vinyl wash primer.
2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
3) Topcoat: Aluminum paint.

e. Institutional Low-Odor/VOC Latex System: MPI INT 5.4G.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

f. High-Performance Architectural Latex System: MPI INT 5.4F.
1) Prime Coat: Quick-drying primer for aluminum.

2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

8. Glue-Laminated Beam and Column Substrates:
   a. Latex System: MPI INT 6.1M.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat: Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Alkyd Primer System: MPI INT 6.1A.
      1) Prime Coat: Interior alkyd primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd System: MPI INT 6.1B.
      1) Prime Coat: Interior alkyd primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Institutional Low-Odor/VOC Latex System: MPI INT 6.1Q.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
      3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
   e. High-Performance Architectural Latex System: MPI INT 6.1N.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat: High-performance architectural latex matching topcoat.
      3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
9. Dressed Lumber Substrates: Including architectural woodwork and doors.
   a. Latex System: MPI INT 6.3T.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat: Interior latex matching topcoat.
      3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Alkyd Primer System: MPI INT 6.3U.
      1) Prime Coat: Interior alkyd primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd System: MPI INT 6.3B.
      1) Prime Coat: Interior alkyd primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Institutional Low-Odor/VOC Latex System: MPI INT 6.3V.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
      3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
   e. High-Performance Architectural Latex System: MPI INT 6.3A.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat: High-performance architectural latex matching topcoat.

3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

10. Wood Panel Substrates: Including painted plywood, medium-density fiberboard, and hardboard.
    a. Latex System: MPI INT 6.4R.
        1) Prime Coat: Interior latex-based wood primer.
        2) Intermediate Coat: Interior latex matching topcoat.
        3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.
    b. Latex Over Alkyd Primer System: MPI INT 6.4A.
        1) Prime Coat: Interior alkyd primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
        3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
    c. Alkyd System: MPI INT 6.4B.
        1) Prime Coat: Interior alkyd primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
        3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
    d. Institutional Low-Odor/VOC Latex System: MPI INT 6.4T.
        1) Prime Coat: Interior latex-based wood primer.
        2) Intermediate Coat : Institutional low-odor/VOC interior latex matching topcoat.
        3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
    e. High-Performance Architectural Latex System: MPI INT 6.4S.
        1) Prime Coat: Interior latex-based wood primer.
        2) Intermediate Coat: High-performance architectural latex matching topcoat.
        3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
11. Dimension Lumber Substrates, Nontraffic Surfaces: Including exposed joists and exposed beams.
    a. Latex System: MPI INT 6.2D.
        1) Prime Coat: Interior latex-based wood primer.
        2) Intermediate Coat: Interior latex matching topcoat.
        3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
    b. Latex Over Alkyd Primer System: MPI INT 6.2A.
        1) Prime Coat: Interior alkyd primer/sealer.
        2) Intermediate Coat : Interior latex matching topcoat.
        3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
    c. Alkyd System: MPI INT 6.2C.
        1) Prime Coat: Interior alkyd primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
        3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
    d. Institutional Low-Odor/VOC Latex System: MPI INT 6.2L.
        1) Prime Coat: Interior latex-based wood primer.
        2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
        3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
    e. High-Performance Architectural Latex System: MPI INT 6.2B.
        1) Prime Coat: Interior alkyd primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
        3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

12. Wood Substrates, Traffic Surfaces:
    a. Latex Floor Paint System: MPI INT 6.5G.
        1) Prime Coat: Interior alkyd primer/sealer.
        2) Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
        3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).
    b. Alkyd Floor Enamel System: MPI INT 6.5A.
        1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
        2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
        3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
13. Gypsum Board Substrates:
    a. Latex System: MPI INT 9.2A.
        1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
        2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
        3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
    b. Alkyd Over Latex Primer System: MPI INT 9.2C.
        1) Prime Coat: Interior latex primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
        3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
    c. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
        1) Prime Coat: Interior latex primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
        3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
    d. High-Performance Architectural Latex System: MPI INT 9.2B.
        1) Prime Coat: Interior latex primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
        3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
14. Plaster Substrates:
    a. Latex System: MPI INT 9.2A.
        1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
        2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
        3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
    b. Latex Over Alkyd Primer System: MPI INT 9.2K.
        1) Prime Coat: Interior alkyd primer/sealer.
        2) Intermediate Coat: Interior latex matching topcoat.
        3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
    c. Alkyd Over Latex Primer System: MPI INT 9.2C.
        1) Prime Coat: Interior latex primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
        3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
    d. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
        1) Prime Coat: Interior latex primer/sealer.
        2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.

3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 9.2B.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

15. Spray-Textured Ceiling Substrates:
a. Latex (Flat) System: MPI INT 9.1A, spray applied.
1) Prime Coat: Interior latex primer/sealer **OR** (flat), **as directed**.
2) Topcoat: Interior latex (flat).
b. Latex System: MPI INT 9.1E, spray applied.
1) Prime Coat: Interior latex matching topcoat.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
c. Latex Over Alkyd Primer System: MPI INT 9.1B.
1) Prime Coat: Interior alkyd primer/sealer.
2) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
d. Alkyd (Flat) System: MPI INT 9.1C.
1) Prime Coat: Interior alkyd (flat).
2) Topcoat: Interior alkyd (flat).
e. Alkyd System: MPI INT 9.1D.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

16. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.
a. Latex System: MPI INT 10.1A.
1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
b. Alkyd Over Latex Primer System: MPI INT 10.1B.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
c. Aluminum Paint System: MPI INT 10.1C.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
3) Topcoat: Aluminum paint.
d. Institutional Low-Odor/VOC Latex System: MPI INT 10.1D.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

END OF SECTION 09 91 23 00

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Task	Specification	Specification Description
09 91 23 00	09 91 13 00	Exterior Painting
09 91 33 00	09 93 00 00	Staining and Transparent Finishing

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SECTION 09 93 00 00 - STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Primers
2. Wood stains.
3. Transparent finishes.

B. Related Requirements:

1. Section 099123 "Interior Painting" for stains and transparent finishes on concrete floors.
2. Section 099600 "High-Performance Coatings" for transparent high-performance coatings on concrete floors and clay masonry.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
2. Include preparation requirements and application instructions.
3. Indicate VOC content.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

C. Samples for Verification: Sample for each type of finish system and in each color and gloss of finish required on representative samples of actual wood substrates.

1. Size: [**8 inches (200 mm) square**][**or**][**8 inches (200 mm) long**].
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

E. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.
3. Environmental Product Declaration: For each product.
4. Health Product Declaration: For each product.
5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.

9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials[**, from the same product run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Stains and Transparent Finishes: [**5**]<**Insert number**> percent, but not less than [**1 gal. (3.8 L)**]<**Insert number**> of each material and color applied.

1.4 MOCKUPS

A. Apply mockups of each finish system indicated and each color selected [**to verify preliminary selections made under Sample submittals**][**to demonstrate aesthetic effects**][**and**][**to set quality standards for materials and execution**].

1. Architect will select one surface to represent surfaces and conditions for application of each type of finish system and substrate.

a. Vertical and Horizontal Surfaces: Provide samples of at least **100 sq. ft. (9 sq. m)**.
b. Other Items: Architect will designate items or areas required.

2. Final approval of stain color selections will be based on mockups.

a. If preliminary stain color selections are not approved, apply additional mockups of additional stain colors selected by Architect at no added cost to Owner.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures of less than **5 deg F (3 deg C)** above the dew point, or to damp or wet surfaces.

C. Do not apply exterior finishes in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations: Obtain each coating product from single source from single manufacturer.

2.2 STAINING AND TRANSPARENT FINISHING

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Behr Paint Company (Behr Process LLC)**]
2. [**Benjamin Moore & Co.**]
3. [**Coronado Paint; Benjamin Moore & Co.**]
4. [**Diamond Vogel Paint Company**]
5. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
6. [**Hempel (USA), Inc.**]
7. [**Lenmar Lacquers; Benjamin Moore & Co.**]
8. [**PPG Paints; PPG Industries, Inc.**]
9. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
10. [**Rodda Paint Co.**]
11. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
12. [**Sherwin-Williams Company (The)**]
13. [**United Gilsonite Laboratories (UGL)**]
14. [**Vista Paint Corporation**]
15. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Behr Paint Company (Behr Process LLC)**]
2. [**Benjamin Moore & Co.**]
3. [**Coronado Paint; Benjamin Moore & Co.**]
4. [**Diamond Vogel Paint Company**]
5. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
6. [**Hempel (USA), Inc.**]
7. [**Lenmar Lacquers; Benjamin Moore & Co.**]
8. [**PPG Paints; PPG Industries, Inc.**]
9. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
10. [**Rodda Paint Co.**]
11. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
12. [**Sherwin-Williams Company (The)**]
13. [**United Gilsonite Laboratories (UGL)**]
14. [**Vista Paint Corporation**]
15. <**Insert manufacturer's name**>

C. Material Compatibility:

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

D. VOC Content, LEED 2009: For field applications that are inside the weatherproofing system, paints and

coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Clear Wood Finishes, Varnishes: 350 g/L.
2. Clear Wood Finishes, Lacquers: 550 g/L.
3. Shellacs, Clear: 730 g/L.
4. Stains: 250 g/L.

E. Low-Emitting Materials, LEED 2009: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. VOC Content, LEED v4: For field applications[**that are inside the weatherproofing system**], paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Primers, Sealers, and Undercoaters: 100 g/L.
2. Clear Wood Finishes, Varnishes: 275 g/L.
3. Clear Wood Finishes, Lacquers: 275 g/L.
4. Shellacs, Clear: 730 g/L.
5. Stains: 100 g/L.

G. Low-Emitting Materials, LEED v4: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Material Emissions and Pollutant Control: Not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

I. Emissions Requirements: Field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Shellacs, Clear: 730 g/L.
    b. Stains: 250 g/L.
    c. Clear Wood Finishes (Varnishes, Sanding Sealers, and Lacquers): 275 g/L.

J. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

K. Stain Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule**]<**Insert requirements**>.

2.3 PRIMERS

A. Primer, Alkyd Oil for Exterior Wood: Alkyd/oil-based primer for exterior wood with resistance to bleeding.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Benjamin Moore & Co.**]
b. [**Diamond Vogel Paint Company**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Rodda Paint Co.**]
e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Benjamin Moore & Co.**]
b. [**Diamond Vogel Paint Company**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Rodda Paint Co.**]
e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. <**Insert manufacturer's name**>

B. Primer, Latex for Exterior Wood: Pigmented, water-borne, emulsion-type primer for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
g. [**Rodda Paint Co.**]
h. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
i. [**Sherwin-Williams Company (The)**]
j. [**Vista Paint Corporation**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
g. [**Rodda Paint Co.**]
h. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
i. [**Sherwin-Williams Company (The)**]
j. [**Vista Paint Corporation**]
k. <**Insert manufacturer's name**>

C. Preservative for Exterior Wood: Solvent-based, penetrating anti-fungal treatment for exterior wood consisting mainly of zinc or copper napthenate.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
b. <**Insert manufacturer's name**>

D. Alkyd Sanding Sealer, Interior, Solvent Based, Clear: Solvent-based, quick-drying, clear, sandable alkyd sealer used on new interior wood surfaces that are to be top-coated with an alkyd varnish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PPG Paints; PPG Industries, Inc.**]
b. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
c. [**Rodda Paint Co.**]
d. [**Sherwin-Williams Company (The)**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**PPG Paints; PPG Industries, Inc.**]
b. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
c. [**Rodda Paint Co.**]
d. [**Sherwin-Williams Company (The)**]
e. <**Insert manufacturer's name**>

2.4 WOOD STAINS

A. Stain, Exterior, Solvent Based, Semitransparent: Solvent-based, oil or oil/alkyd, semitransparent, pigmented stain for new wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Rodda Paint Co.**]
f. [**Sherwin-Williams Company (The)**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Rodda Paint Co.**]
f. [**Sherwin-Williams Company (The)**]
g. <**Insert manufacturer's name**>

B. Stain, Exterior, Solvent Based, Solid Hide: Solvent-based, oil or oil/alkyd, pigmented stain for new, or previously stained, wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Diamond Vogel Paint Company**]
b. [**Sherwin-Williams Company (The)**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Diamond Vogel Paint Company**]
b. [**Sherwin-Williams Company (The)**]
c. <**Insert manufacturer's name**>

C. Stain, Exterior, Water Based, Solid Hide: Water-based, solid-hide, emulsion-type, pigmented stain for primed or previously painted exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
g. [**Sherwin-Williams Company (The)**]
h. [**Vista Paint Corporation**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Diamond Vogel Paint Company**]
d. [**Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company)**]
e. [**PPG Paints; PPG Industries, Inc.**]
f. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
g. [**Sherwin-Williams Company (The)**]
h. [**Vista Paint Corporation**]
i. <**Insert manufacturer's name**>

D. Stain, Exterior, Water Based, Semitransparent: Water-based, semitransparent, pigmented stain for new wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Coronado Paint; Benjamin Moore & Co.**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Coronado Paint; Benjamin Moore & Co.**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]
f. <**Insert manufacturer's name**>

E. Stain, Exterior, for Wood Decks: Solvent- or water- based, modified-oil or alkyd-type, semitransparent, penetrating stain for exterior dimensional wood decking.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Diamond Vogel Paint Company**]
    d. [**PPG Paints; PPG Industries, Inc.**]
    e. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
    f. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    g. [**Sherwin-Williams Company (The)**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**Benjamin Moore & Co.**]
    c. [**Diamond Vogel Paint Company**]
    d. [**PPG Paints; PPG Industries, Inc.**]
    e. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
    f. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    g. [**Sherwin-Williams Company (The)**]
    h. <**Insert manufacturer's name**>

F. Stain, Interior, Semitransparent, for Interior Wood: Solvent-based, oil or oil/alkyd, semitransparent, pigmented stain for new interior wood surfaces that are to be finished with a clear varnish.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**PPG Paints; PPG Industries, Inc.**]
    c. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
    d. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    e. [**Sherwin-Williams Company (The)**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Behr Paint Company (Behr Process LLC)**]
    b. [**PPG Paints; PPG Industries, Inc.**]
    c. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
    d. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    e. [**Sherwin-Williams Company (The)**]
    f. <**Insert manufacturer's name**>

G. Shellac: Alcohol-based, shellac type, clear or light amber-colored coating for use as a sealer on stains and knots or as a wash coat to even the porosity of some wood types.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    b. [**Sherwin-Williams Company (The)**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
    b. [**Sherwin-Williams Company (The)**]
    c. <**Insert manufacturer's name**>

H. Danish Oil: Solvent-based, oil-type, penetrating stain for application by brush or wiping on interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Sherwin-Williams Company (The)**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Sherwin-Williams Company (The)**]
    b. <**Insert manufacturer's name**>

2.5 TRANSPARENT FINISHES

A. Varnish, Marine Spar, Exterior, Gloss: Solvent-based, phenolic-modified clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Sherwin-Williams Company (The)**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Sherwin-Williams Company (The)**]
    b. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

B. Varnish with UV Inhibitor, Exterior, Gloss: Solvent-based, alkyd-type, clear gloss varnish stabilized against UV deterioration for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Sherwin-Williams Company (The)**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Sherwin-Williams Company (The)**]
   b. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

C. Varnish with UV Inhibitor, Exterior, Semigloss: Solvent-based, alkyd-type, clear semigloss varnish stabilized against UV deterioration for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Sherwin-Williams Company (The)**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Sherwin-Williams Company (The)**]
   b. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard semigloss finish**][**Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

D. Varnish, Exterior, Aliphatic Polyurethane, Two Component: Solvent-based, two-component, aliphatic polyurethane clear coating used on exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hempel (USA), Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Hempel (USA), Inc.**]
    b. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of minimum 80 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

E. Varnish, Exterior, Water Based, Eggshell: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. <**Insert manufacturer's name**>

3. Gloss and Sheen Level: Gloss and Sheen Level: [**Manufacturer's standard eggshell finish**][**Gloss of 10 to 25 units at 60 degrees and sheen of 10 to 35 units at 85 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

F. Varnish, Exterior, Water Based, Satin: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. [**Sherwin-Williams Company (The)**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. [**Sherwin-Williams Company (The)**]
    c. <**Insert manufacturer's name**>

3. Gloss and Sheen Level: [**Manufacturer's standard low-sheen finish**][**Gloss of 20 to 35 units at 60 degrees and minimum sheen of 35 units at 85 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

G. Varnish, Exterior, Water Based, Semigloss: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. [**Sherwin-Williams Company (The)**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. [**Sherwin-Williams Company (The)**]
    c. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard semigloss finish**][**Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

H. Varnish, Exterior, Water Based, Gloss: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

I. Varnish, Exterior, Water Based, High Gloss: Water-based clear varnish for exterior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**PPG Paints; PPG Industries, Inc.**]
    b. [**Sherwin-Williams Company (The)**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**PPG Paints; PPG Industries, Inc.**]

b. [**Sherwin-Williams Company (The)**]
c. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of minimum 85 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

J. Varnish, Interior Polyurethane, Moisture Cured, Gloss: Solvent-based, moisture-curing polyurethane clear-coating with a gloss finish for interior wood surfaces,

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Benjamin Moore & Co.**]
b. [**Sherwin-Williams Company (The)**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Benjamin Moore & Co.**]
b. [**Sherwin-Williams Company (The)**]
c. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

K. Varnish, Interior, Polyurethane, Oil Modified, Gloss: Solvent-based, one-component, oil-modified polyurethane clear gloss varnish for new or previously varnished or stained interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Rodda Paint Co.**]
e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. [**United Gilsonite Laboratories (UGL)**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Rodda Paint Co.**]
e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]

f. [**Sherwin-Williams Company (The)**]
g. [**United Gilsonite Laboratories (UGL)**]
h. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

L. Varnish, Interior, Polyurethane, Oil Modified, Satin: Solvent-based, one-component, oil-modified polyurethane clear satin varnish for new or previously varnished or stained interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Rodda Paint Co.**]
e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. [**United Gilsonite Laboratories (UGL)**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**PPG Paints; PPG Industries, Inc.**]
d. [**Rodda Paint Co.**]
e. [**Rust-Oleum Corporation; a subsidiary of RPM International, Inc.**]
f. [**Sherwin-Williams Company (The)**]
g. [**United Gilsonite Laboratories (UGL)**]
h. <**Insert manufacturer's name**>

3. Gloss and Sheen Level: [**Manufacturer's standard low-sheen finish**][**Gloss of 20 to 35 units at 60 degrees and minimum sheen of 35 units at 85 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

M. Varnish, Interior, Flat/Satin: Solvent-based, alkyd-type, clear flat/satin varnish for new or properly prepared, previously varnished interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Sherwin-Williams Company (The)**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Sherwin-Williams Company (The)**]
b. <**Insert manufacturer's name**>

3. Gloss and Sheen Level: [**Manufacturer's standard flat finish**][**Maximum gloss of 5 units at 60 degrees and maximum sheen of 10 units at 85 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

N. Varnish, Interior, Gloss: Solvent-based, alkyd-type, clear gloss varnish for new or properly prepared, previously varnished interior wood surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PPG Paints; PPG Industries, Inc.**]
b. [**Sherwin-Williams Company (The)**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**PPG Paints; PPG Industries, Inc.**]
b. [**Sherwin-Williams Company (The)**]
c. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

O. Varnish, Interior, Water Based, Clear, Satin: Water-based clear satin coating for interior wood trim, frames, doors, paneling and cabinetry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Lenmar Lacquers; Benjamin Moore & Co.**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Lenmar Lacquers; Benjamin Moore & Co.**]
d. [**PPG Paints; PPG Industries, Inc.**]
e. [**Sherwin-Williams Company (The)**]
f. <**Insert manufacturer's name**>

3. Gloss and Sheen Level: [**Manufacturer's standard low-sheen finish**][**Gloss of 20 to 35 units at 60 degrees and minimum sheen of 35 units at 85 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

P. Varnish, Interior, Water Based, Clear, Semigloss: Water-based clear semigloss coating for interior wood trim, frames, doors, paneling and cabinetry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Benjamin Moore & Co.**]
   b. [**Lenmar Lacquers; Benjamin Moore & Co.**]
   c. [**PPG Paints; PPG Industries, Inc.**]
   d. [**Sherwin-Williams Company (The)**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Benjamin Moore & Co.**]
   b. [**Lenmar Lacquers; Benjamin Moore & Co.**]
   c. [**PPG Paints; PPG Industries, Inc.**]
   d. [**Sherwin-Williams Company (The)**]
   e. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard semigloss finish**][**Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523**]<**Insert requirements**>.

Q. Varnish, Interior, Water Based, Clear, High Gloss: Water-based clear high-gloss coating for interior wood trim, frames, doors, paneling and cabinetry.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Benjamin Moore & Co.**]
   b. [**Lenmar Lacquers; Benjamin Moore & Co.**]
   c. [**PPG Paints; PPG Industries, Inc.**]
   d. [**Sherwin-Williams Company (The)**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Benjamin Moore & Co.**]
   b. [**Lenmar Lacquers; Benjamin Moore & Co.**]
   c. [**PPG Paints; PPG Industries, Inc.**]
   d. [**Sherwin-Williams Company (The)**]
   e. <**Insert manufacturer's name**>

3. Gloss Level: [**Manufacturer's standard gloss finish**][**Gloss of minimum 85 units at 60**

degrees when tested in accordance with ASTM D523]<**Insert requirements**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.

C. Maximum Moisture Content of Interior Wood Substrates: [**15**][**13**][**10**][**9**] percent, when measured with an electronic moisture meter.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with finish application only after unsatisfactory conditions have been corrected.

1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.

1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

B. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.

1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

C. Exterior Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Prime edges, ends, faces, undersides, and backsides of wood.

a. For solid hide stained wood, stain edges and ends after priming.
b. For varnish-coated stained wood, stain edges and ends and prime with varnish. Prime undersides and backsides with varnish.

3. Countersink steel nails, if used, and fill with putty or plastic wood filler tinted to final color. Sand smooth when dried.

D. Interior Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Apply wood filler paste to open-grain woods to produce smooth, glasslike finish.
3. Sand surfaces exposed to view and dust off.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dry.

3.3 APPLICATION

A. Apply finishes according to manufacturer's written instructions.

1. Use applicators and techniques suited for finish and substrate indicated.
2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 EXTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. Wood Substrates, Glued-Laminated Construction:

1. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

2. Varnish over Semitransparent Stain System :

a. Stain Coat: Stain, exterior, solvent based, semitransparent.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

3. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Water-based varnish, [**eggshell**][**satin**][**semigloss**][**gloss**][**high gloss**].

4. Varnish System :

a. Prime Coat: Varnish matching topcoat.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

5. Clear, Two-Component Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, exterior, solvent based, semitransparent.
b. First Intermediate Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
c. Second Intermediate Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
d. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

6. Clear, Two-Component Polyurethane Varnish System :

a. Prime Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
b. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

B. Wood Substrates, Exposed Framing:

1. Solid-Color, Water-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

3. Water-Based Semitransparent Stain System :

a. Prime Coat: Stain, exterior, water based, semitransparent, matching topcoat.
b. Intermediate Coat: Stain, exterior, water based, semitransparent, matching topcoat.
c. Topcoat: Stain, exterior, water based, semitransparent.

4. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

5. Varnish over Stain System :

a. Stain Coat: Stain, exterior, solvent based, semitransparent.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.

d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

6. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Water-based varnish, [**eggshell**][**satin**][**semigloss**][**gloss**][**high gloss**].

7. Varnish System :

a. Prime Coat: Varnish matching topcoat.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

8. Clear, Two-Component Polyurethane Varnish System :

a. Prime Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, [**gloss**][**high gloss**].

C. Wood Substrates, [**Wood Trim**][**Architectural woodwork**][**Doors**][**Windows**][**Wood Board Siding**][**and**][**Wood Fences**]:

1. Solid-Color, Water-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

3. Water-Based Semitransparent Stain System :

a. Prime Coat: Stain, exterior, water based, semitransparent, matching topcoat.
b. Intermediate Coat: Stain, exterior, water based, semitransparent, matching topcoat.
c. Topcoat: Stain, exterior, water based, semitransparent.

4. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

5. Varnish over Stain System :

a. Stain Coat: Stain, exterior, solvent-based, semitransparent.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

6. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Water-based varnish, [**eggshell**][**satin**][**semigloss**][**gloss**][**high gloss**].

7. Varnish System :

a. Prime Coat: Varnish matching topcoat.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

8. Clear, Two-Component Polyurethane Varnish System :

a. Prime Coat: Varnish, aliphatic polyurethane, two component, matching topcoat.
b. Topcoat: Varnish, aliphatic polyurethane, two component gloss.

D. Wood Substrates, Wood-Based Panel Products:

1. Solid-Color, Water-Based Stain System :

a. Prime Coat: Primer, [**latex**][**alkyd**] for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

3. Water-Based Semitransparent Stain System :

a. Prime Coat: Stain, exterior, water based, semitransparent, matching topcoat.
b. Intermediate Coat: Stain, exterior, water based, semitransparent, matching topcoat.
c. Topcoat: Stain, exterior, water based, semitransparent.

4. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

5. Varnish over Stain System :

a. Stain Coat: Stain, exterior, solvent based, semitransparent.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

6. Varnish System :

a. Prime Coat: Varnish matching topcoat.
b. First Intermediate Coat: Varnish matching topcoat.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, with UV inhibitor, exterior, [**semigloss**][**gloss**][**high gloss**].

E. Wood Substrates, Traffic Surfaces, Including [**Lumber Decking**][**and**][**Stairs**]:

1. Deck Stain over Wood Preservative System :

a. Preservative Coat: Preservative, for exterior wood.
b. Intermediate Coat: Stain, for exterior wood decks, matching topcoat.
c. Topcoat: Stain, for exterior wood decks.

2. Deck Stain System :

a. Prime Coat: Stain, for exterior wood decks, matching topcoat.
b. Topcoat: Stain, for exterior wood decks.

F. Wood Substrates, Wood Shingles and Shakes (Excluding Roofs):

1. Solid-Color, Water-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, solvent based, solid hide.

3. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

3.6 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. Wood Substrates, Glued-Laminated Construction:

1. Solid-Color Latex Stain System :

a. Prime Coat: Primer, alkyd for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, solid hide.

3. Semitransparent Stain System :

a. Prime Coat: Stain, semitransparent, matching topcoat.
b. Topcoat: Stain, semitransparent, for interior wood.

4. Water-Based Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Water-based varnish matching topcoat.
c. Second Intermediate Coat: Water-based varnish matching topcoat.
d. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

5. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

6. Alkyd Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: [**Varnish matching topcoat**][**Alkyd, sanding sealer, clear**].
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, interior, [**flat**][**gloss**].

7. Alkyd Varnish System :

a. Prime Coat: Alkyd, sanding sealer, clear.
b. Intermediate Coat: Varnish matching topcoat.
c. Topcoat: Varnish, interior, [**flat**][**gloss**].

8. Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

9. Polyurethane Varnish System :

a. Prime Coat: Polyurethane varnish matching topcoat.
b. Intermediate Coat: Polyurethane varnish matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

10. Moisture-Cured Clear Polyurethane over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

11. Clear, Two-Component Polyurethane System :

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

B. Wood Substrates, Exposed Framing:

1. Water-Based Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Water-based varnish matching topcoat.
c. Second Intermediate Coat: Water-based varnish matching topcoat.
d. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

2. Alkyd Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Alkyd, sanding sealer, clear.
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, interior, [**flat**][**gloss**].

3. Alkyd Varnish System :

a. Prime Coat: Alkyd, sanding sealer, clear.
b. Intermediate Coat: Varnish matching topcoat.
c. Topcoat: Varnish, interior, [**flat**][**gloss**].

4. Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

5. Polyurethane Varnish System :

a. Prime Coat: Polyurethane varnish matching topcoat.
b. Intermediate Coat: Polyurethane varnish matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

6. Moisture-Cured Clear Polyurethane over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

7. Clear, Two-Component Polyurethane System :

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

C. Wood Substrates, [**Wood Trim**][**Architectural Woodwork**][**Doors**][**Windows**][**and**][**Wood Board Paneling**]:

1. Semitransparent Stain System :

a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, semitransparent.

2. Water-Based Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.

b. First Intermediate Coat: Water-based varnish matching topcoat.
c. Second Intermediate Coat: Water-based varnish matching topcoat.
d. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

3. Water-Based Varnish System :

a. Prime Coat: Water-based varnish matching topcoat.
b. Intermediate Coat: Water-based varnish matching topcoat.
c. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

4. Alkyd Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: [**Alkyd, sanding sealer, clear**][**Shellac, clear**].
c. Second Intermediate Coat: Varnish matching topcoat.
d. Topcoat: Varnish, interior, [**flat**][**gloss**].

5. Alkyd Varnish System :

a. Prime Coat: [**Alkyd, sanding sealer, clear**][**Shellac, clear**].
b. Intermediate Coat: Varnish matching topcoat.
c. Topcoat: Varnish, interior, [**flat**][**gloss**].

6. Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

7. Polyurethane Varnish System :

a. Prime Coat: Polyurethane varnish matching topcoat.
b. Intermediate Coat: Polyurethane varnish matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

8. Moisture-Cured Clear Polyurethane over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

9. Moisture-Cured Clear Polyurethane System :

a. Prime Coat: Moisture-cured polyurethane matching topcoat.
b. Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Topcoat: Varnish, polyurethane, moisture cured, gloss.

10. Clear, Two-Component Polyurethane System :

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

11. Danish Oil System :

    a. Prime Coat: Danish oil matching topcoat.
    b. Topcoat: Danish oil.

D. Wood Substrates, [**Wood Paneling**][**and**][**Casework**]:

1. Semitransparent Stain System :

    a. Prime Coat: Stain, exterior, solvent based, semitransparent, matching topcoat.
    b. Topcoat: Stain, exterior, solvent based, semitransparent.

2. Water-Based Varnish over Stain System :

    a. Stain Coat: Stain, semitransparent, for interior wood.
    b. First Intermediate Coat: Water-based varnish matching topcoat.
    c. Second Intermediate Coat: Water-based varnish matching topcoat.
    d. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

3. Water-Based Varnish System :

    a. Prime Coat: Water-based varnish matching topcoat.
    b. Intermediate Coat: Water-based varnish matching topcoat.
    c. Topcoat: Varnish, water based, clear, [**satin**][**semigloss**][**gloss**].

4. Alkyd Varnish over Stain System :

    a. Stain Coat: Stain, semitransparent, for interior wood.
    b. First Intermediate Coat: [**Alkyd, sanding sealer, clear**][**Shellac, clear**].
    c. Second Intermediate Coat: Varnish matching topcoat.
    d. Topcoat: Varnish, interior, [**flat**][**gloss**].

5. Alkyd Varnish System :

    a. Prime Coat: Alkyd, sanding sealer, clear [**Shellac, clear**].
    b. Intermediate Coat: Varnish matching topcoat.
    c. Topcoat: Varnish, interior, [**flat**][**gloss**].

6. Polyurethane Varnish over Stain System :

    a. Stain Coat: Stain, semitransparent, for interior wood.
    b. First Intermediate Coat: Polyurethane varnish matching topcoat.
    c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
    d. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

7. Polyurethane Varnish System :

    a. Prime Coat: Polyurethane varnish matching topcoat.
    b. Intermediate Coat: Polyurethane varnish matching topcoat.
    c. Topcoat: Varnish, interior, polyurethane, oil modified, [**satin**][**gloss**].

8. Moisture-Cured Clear Polyurethane over Stain System :

    a. Stain Coat: Stain, semitransparent, for interior wood.
    b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.

c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

9. Danish Oil System :

a. Prime Coat: Danish oil matching topcoat.
b. Topcoat: Danish oil.

E. Wood Substrates, Traffic Surfaces, Including [**Floors**][**and**][**Stairs**]:

1. Polyurethane Varnish over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, gloss.

2. Polyurethane Varnish System :

a. Prime Coat: Polyurethane varnish matching topcoat.
b. Intermediate Coat: Polyurethane varnish matching topcoat.
c. Topcoat: Varnish, interior, polyurethane, oil modified, gloss.

3. Moisture-Cured Clear Polyurethane over Stain System :

a. Stain Coat: Stain, semitransparent, for interior wood.
b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

4. Moisture-Cured Clear Polyurethane System :

a. Prime Coat: Moisture-cured polyurethane matching topcoat.
b. Intermediate Coat: Moisture-cured polyurethane matching topcoat.
c. Topcoat: Varnish, polyurethane, moisture cured, gloss.

5. Clear, Two-Component Polyurethane System :

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component, gloss.

F. Wood Substrates, Wood Shingles and Shakes:

1. Solid-Color Latex Stain System :

a. Prime Coat: Primer, latex for exterior wood.
b. Intermediate Coat: Stain, exterior, water based, solid hide, matching topcoat.
c. Topcoat: Stain, exterior, water based, solid hide.

2. Solid-Color, Solvent-Based Stain System :

a. Prime Coat: Stain, exterior, solvent based, solid hide, matching topcoat.
b. Topcoat: Stain, exterior, solvent based, solid hide.

3. Semitransparent Stain System :

   a. Prime Coat: Stain, semitransparent, matching topcoat.
   b. Topcoat: Stain, semitransparent, for interior wood.

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Task	Specification	Specification Description
09 93 13 00	09 93 00 00	Staining and Transparent Finishing
09 93 13 53	09 93 00 00	Staining and Transparent Finishing
09 93 23 00	09 93 00 00	Staining and Transparent Finishing
09 93 23 13	09 93 00 00	Staining and Transparent Finishing
09 93 23 53	09 93 00 00	Staining and Transparent Finishing

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SECTION 09 96 00 00 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Block fillers.
2. Interior primers/sealers.
3. Metal primers.
4. Epoxy coatings.
5. Polyurethane coatings.

B. Related Requirements:

1. [**Section 051200 "Structural Steel Framing"**][**Section 051213 "Architecturally Exposed Structural Steel Framing"**] for shop priming structural steel substrates with primers specified in this Section.
2. Section 055213 "Pipe and Tube Railings" for shop priming and painting pipe and tube railings with coatings specified in this Section.
3. Section 099113 "Exterior Painting" for general field painting.
4. Section 099123 "Interior Painting" for general field painting.
5. Section 099300 "Staining and Transparent Finishing" for general field staining.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of coating system and each color and gloss of topcoat. Submit [**actual paint drawdowns as specified below**][**paint manufacturer's standard printed cards**] for verification Samples.

1. Submit Samples on actual substrate material to be coated, **8 inches (200 mm)** square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in High-Performance Coating Schedules. Include color designations and production runs (batch numbers).

E. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.

2. Environmental Product Declaration (EPD): For each product.

3. Health Product Declaration (HPD): For each product.

4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

5. Environmental Product Declaration (EPD): For each product.

6. Health Product Declaration (HPD): For each product.

7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

8. Environmental Product Declaration (EPD): For each product.

9. Environmental Product Declaration (EPD): For each product.

10. Environmental Product Declaration (EPD): For each product.
11. Third-Party Certifications: For each product.
12. Third-Party-Certified Life-Cycle Assessment: For each product.

13. Product Data for Green Seal GS-11 Certification: Green Seal GS-11 certification.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials [**from the same production run (batch number),**] that match coating system products applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: [**5**] percent, but not less than [**1 gal. (3.8 L)**] of each material and color applied.

1.4 MOCKUPS

A. Apply mockups of each coating system indicated and each color and finish selected to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution, as directed by the Owner.

1. Architect will select one surface to represent surfaces and conditions for application of each coating system.

   a. Wall and Ceiling Surfaces: Provide samples of at least **100 sq. ft. (9 sq. m)**.
   b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

   a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to the Owner, as directed by the Owner.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each coating system product from single source from single manufacturer.

2.2 HIGH-PERFORMANCE COATING PRODUCTS, GENERAL

A. High-Performance Coating Products: Subject to compliance with requirements, [**provide product**][**provide one of the products**][**available products that may be incorporated into the Work include but are not limited to products**] listed in product types below and applicable exterior and interior high-performance coating schedule articles for the coating category indicated.

B. Material Compatibility:

1. Materials for use within each coating system must be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
2. For each coat in a coating system, provide products recommended in writing by topcoat manufacturer for use in system and on substrate indicated.

C. VOC Content: For field applications [**that are inside the weatherproofing system**] , verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.
4. Rust-Preventive Coatings: 100 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
6. Pretreatment Wash Primers: 420 g/L.
7. Floor Coatings: 50 g/L.
8. Shellacs, Clear: 730 g/L.

9. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Verify that not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with either of the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. Verify VOC content does not exceed limits of authorities having jurisdiction and the following:

a. Flat Coatings: 50 g/L.
b. Nonflat Coatings: 100 g/L.
c. Nonflat - High-Gloss Coatings: 150 g/L.
d. Concrete/Masonry Sealers: 100 g/L.
e. Floor Coatings: 100 g/L.
f. Industrial Maintenance Coatings: 250 g/L.
g. Low-Solids Coatings: 120 g/L.
h. Mastic Texture Coatings: 100 g/L.
i. Metallic Pigmented Coatings: 500 g/L.
j. Pretreatment Wash Primers: 420 g/L.
k. Primers, Sealers, and Undercoaters: 100 g/L.
l. Reactive Penetrating Sealers: 350 g/L.
m. Recycled Coatings: 250 g/L.
n. Rust-Preventive Coatings: 250 g/L.

F. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

G. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify paints and coatings comply with VOC emissions evaluation criteria.

H. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in color schedule on Drawings**] as directed by the Owner.

2.3 BLOCK FILLERS

A. Latex Block Filler: Water-based, pigmented, high-solids, emulsion coating formulated to bridge and fill porous surfaces of CMU substrates in preparation for specified subsequent coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

B. Epoxy Block Filler: Solvent-based, two-component, epoxy, high-solids coating; formulated to bridge and fill porous surfaces of CMU substrates in preparation for specified subsequent coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**Sherwin-Williams Company (The)**]
c. [**The Pittsburgh Paints Company**]
d. [**Tnemec Company, Inc.**]

2.4 INTERIOR PRIMERS/SEALERS

A. Interior Latex Primer Sealer: Pigmented, water-based latex sealer; formulated to reduce porosity of substrate for finish coats; for use on new interior plaster, concrete, and gypsum board substrates. Not intended for use on wood or previously painted surfaces.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

B. Knot Sealer: White shellac or other sealer recommended in writing by topcoat manufacturer for sealing wood knots.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]

2.5 METAL PRIMERS

A. Zinc-Rich Inorganic Primer: Corrosion-resistant, inorganic-based, zinc-rich primer; formulated for use on prepared ferrous metal substrates that will be exposed to severe industrial or marine environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Sherwin-Williams Company (The)**]
b. [**The Pittsburgh Paints Company**]
c. [**Tnemec Company, Inc.**]

B. Epoxy Zinc-Rich Primer: Solvent-based, multi-component, epoxy-type anticorrosive primer; formulated for use on cleaned ferrous metal substrates that will be exposed to moderate industrial or marine environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Sherwin-Williams Company (The)**]
b. [**The Pittsburgh Paints Company**]
c. [**Tnemec Company, Inc.**]

C. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer; formulated for resistance to flash rusting when applied to cleaned, ferrous metal substrates subject to mildly corrosive environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

D. Epoxy, Anticorrosive Primer: Solvent-based, two-component, epoxy, anticorrosive primer; formulated for use on ferrous and galvanized metal substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Sherwin-Williams Company (The)**]
b. [**The Pittsburgh Paints Company**]

c. [**Tnemec Company, Inc.**]

E. Vinyl Wash Primer: Two-component, vinyl butyral/phosphoric acid-wash primer formulated for use over cleaned ferrous metal substrates and zinc-rich primers as a tie coat for subsequent corrosion-resistant primers or finish coatings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Sherwin-Williams Company (The)**]
b. [**The Pittsburgh Paints Company**]

2.6 EPOXY COATINGS

A. Epoxy: Solvent-based, two-component epoxy coating; formulated for resistance to incidental splash and spillage of dilute (5 percent) sulfuric acid, (15 percent) hydrochloric acid, (20 percent) sodium hydroxide, gasoline, and heavy-duty cleaners and detergents; for use on wall and floor surfaces in moderate-to-heavy-traffic commercial and moderate industrial environments.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

2. Gloss Level: Manufacturer's standard [**semigloss**][**gloss**] .

B. High-Build Epoxy: Two-component epoxy, high-solids, self-priming coating for use on interior or exterior substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Behr Paint Company (Behr Process LLC)**]
b. [**Benjamin Moore & Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

2. Gloss Level: Manufacturer's standard [**low gloss**][**gloss**] .

C. Epoxy-Modified Latex: Water-based, two-component, epoxy-modified latex paint for use on interior or exterior substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
    b. [**Sherwin-Williams Company (The)**]
    c. [**The Pittsburgh Paints Company**]
    d. [**Tnemec Company, Inc.**]

2. Gloss Level: Manufacturer's standard [**semigloss**][**gloss**] .

D. Epoxy Deck Coating (Slip Resistant): Solvent-based, two-component epoxy, non-slip coating formulated for resistance to abrasion, solvents, fuel, and oils; for use on interior and exterior decks.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Benjamin Moore & Co.**]
    b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
    c. [**Neogard; Hempel Group**]
    d. [**Sherwin-Williams Company (The)**]
    e. [**The Pittsburgh Paints Company**]
    f. [**Tnemec Company, Inc.**]

2.7 POLYURETHANE COATINGS

A. Pigmented Polyurethane: Solvent-based, two-component coating formulated for resistance to abrasion, weathering, and chemical and solvent exposure; for use on interior or exterior substrates.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Benjamin Moore & Co.**]
    b. [**Sherwin-Williams Company (The)**]
    c. [**The Pittsburgh Paints Company**]
    d. [**Tnemec Company, Inc.**]

2. Gloss Level: Manufacturer's standard [**semigloss**][**gloss**] .

B. Varnish, Aliphatic Polyurethane: Clear, solvent-based, two-component coating formulated for use on interior or exterior wood substrates; manufacturer's standard gloss and sheen.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Benjamin Moore & Co.**]
b. [**H&C Decorative Concrete Products; a brand of Sherwin-Williams Co.**]
c. [**Sherwin-Williams Company (The)**]
d. [**The Pittsburgh Paints Company**]
e. [**Tnemec Company, Inc.**]

2.8 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: the Owner reserves the right to invoke the following procedure:

1. the Owner will engage services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. the Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor to remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, both coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Cementitious Composition Board: 12 percent.
3. Masonry (Clay and CMUs): 12 percent.
4. Wood: 15 percent.
5. Portland Cement (Plaster Stucco): 12 percent. Verify that plaster is fully cured.
6. Gypsum Board: 12 percent. Verify that finishing compound is dry and sanded smooth.

C. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of [**1500 to 4000 psi (10 350 to 27 580 kPa)**][**4000 to 10,000 psi (27 580 to 68 950 kPa)**] at **6 to 12 inches (150 to 300 mm)**.
2. Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4.

E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of [**100 to 600 psi (690 to 4140 kPa)**][**600 to 1500 psi (4140 to 10 350 kPa)**][**1500 to 4000 psi (10 350 to 27 580 kPa)**] at **6 to 12 inches (150 to 300 mm)**.

F. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other foreign matter. Clean using methods recommended in writing by coating manufacturer [**.**][**but not less than the following:**]

1. SSPC-SP 7/NACE No. 4.
2. SSPC-SP 11.
3. SSPC-SP 6/NACE No. 3.
4. SSPC-SP 10/NACE No. 2.
5. SSPC-SP 5/NACE No. 1.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer that is recommended in writing by topcoat manufacturer for coating system indicated.

2. Sand surfaces that will be exposed to view and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with filler that is recommended in writing by topcoat manufacturer for coating system indicated. Sand smooth when dried.

3.3 APPLICATION OF HIGH-PERFORMANCE COATINGS

A. Apply coating system products in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: the Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written instructions, apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written instructions.
3. Cost of retesting is Contractor's responsibility.

3.5 CLEANING

A. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 PROTECTION

A. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an

undamaged condition, as directed by the Owner.

3.7 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, CONCRETE SUBSTRATES

A. Vertical (Nontraffic) Surfaces:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, matching intermediate coat.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Horizontal (Traffic) Surfaces:

1. Epoxy Non-Slip Deck Coating System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Epoxy deck coating (slip resistant).

3.8 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, CEMENTITIOUS SUBSTRATES

A. Cementitious Composition Board Substrates: [**Siding**][**Trim**][**Panels**] .

1. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, gloss.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Portland Cement Plaster (Stucco) Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.9 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, MASONRY SUBSTRATES

A. Clay Masonry Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, matching intermediate coat.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. CMU Substrates:

1. Epoxy System:

a. Block Filler: Epoxy block filler.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over High-Build Epoxy System:

a. Block Filler: Epoxy block filler.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.10 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, METAL SUBSTRATES

A. Steel Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy over Self-Priming Epoxy System:

a. Prime Coat: High-build epoxy.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Epoxy Deck Coating over Epoxy Primer and High-Build Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Epoxy deck coating (slip resistant).
d. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

4. Epoxy Deck Coating over Self-Priming Epoxy System:

a. Prime Coat: High-build epoxy.
b. Topcoat: Epoxy deck coating (slip resistant).
c. Additive: Manufacturer's standard additive to increase skid resistance of painted surface.

5. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy, gloss.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

6. Pigmented Polyurethane over High-Build Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

7. Pigmented Polyurethane over Self-Priming Epoxy System:

a. Prime Coat: High-build epoxy.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

8. Pigmented Polyurethane over Epoxy Zinc-Rich Primer System:

a. Prime Coat: Epoxy zinc-rich primer.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

9. Pigmented Polyurethane over Epoxy Zinc-Rich Primer and High-Build Epoxy System:

a. Prime Coat: Epoxy zinc-rich primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

10. Pigmented Polyurethane over Zinc-Rich Inorganic Primer and High-Build Epoxy System:

a. Prime Coat: Zinc-rich inorganic primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Galvanized Metal Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy Primer System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Pigmented Polyurethane over Vinyl Wash Primer and Epoxy Primer System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, anticorrosive primer.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

C. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, anticorrosive primer.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

D. Copper Substrates:

1. Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, anticorrosive primer.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

E. Stainless Steel Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Vinyl wash primer.
b. Intermediate Coat: Epoxy, anticorrosive primer.
c. First and Second Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.11 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, WOOD SUBSTRATES

A. Glued-Laminated Wood Substrates:

1. Pigmented Polyurethane System:

    a. Prime Coat: Pigmented polyurethane, matching topcoat.
    b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Clear (Two-Component) Polyurethane System:

    a. Stain Coat: As specified in Section 099300 "Staining and Transparent Finishing."
    b. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
    c. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
    d. Topcoat: Varnish, aliphatic polyurethane.

B. Exposed Wood-Framed Substrates:

1. Pigmented Polyurethane System:

    a. Prime Coat: Pigmented polyurethane, matching topcoat.
    b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Clear (Two-Component) Polyurethane System:

    a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
    b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
    c. Topcoat: Varnish, aliphatic polyurethane.

C. Dressed Wood Substrates: [**Wood trim**][**Architectural woodwork**][**Doors**][**Windows**][**Wood board siding**][**Railings**][**and**][**Fences**] .

1. Pigmented Polyurethane System:

    a. Prime Coat: Pigmented polyurethane, matching topcoat.
    b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Clear (Two-Component) Polyurethane System:

    a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
    b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
    c. Topcoat: Varnish, aliphatic polyurethane.

3.12 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE, MISCELLANEOUS SUBSTRATES

A. Fiberglass Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Epoxy, matching intermediate coat.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.13 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, CONCRETE SUBSTRATES

A. Vertical (Nontraffic) Surfaces:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy, High-Build System:

a. Prime Coat: High-build epoxy, matching topcoat (reduced).
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: Low gloss.

3. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Horizontal (Traffic) Surfaces.

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy, High-Build System:

a. Prime Coat: High-build epoxy, matching topcoat (reduced).
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: [**Low gloss**][**Gloss**] .

3. Pigmented Polyurethane System:

a. Prime Coat: Epoxy, gloss.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

4. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

3.14 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, CEMENTITIOUS SUBSTRATES

A. Cementitious Composition Board Substrates: [**Siding**][**Trim**][**Panels**] .

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.15 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, MASONRY SUBSTRATES

A. Clay Masonry Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

B. CMU Substrates:

1. Epoxy System for Dry Environments:

a. Block Filler: Latex block filler.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy System for Wet Environments:

a. Block Filler: Epoxy block filler.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Epoxy, High-Build System:

a. Prime Coat: Epoxy block filler.
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: [**Low gloss**][**Gloss**] .

4. Epoxy-Modified Latex System:

a. Block Filler: Latex block filler.
b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

5. Clear (Two-Component) Polyurethane System:

    a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
    b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
    c. Topcoat: Varnish, aliphatic polyurethane.

3.16 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, METAL SUBSTRATES

A. Steel Substrates:

1. Epoxy System:

    a. Prime Coat: Epoxy, anticorrosive primer.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

2. High-Build Epoxy over Epoxy Zinc-Rich Primer System:

    a. Prime Coat: Epoxy zinc-rich primer.
    b. Intermediate Coat: High-build epoxy, low gloss.
    c. Topcoat: Epoxy.

        1) Gloss Level: [**Low gloss**][**Gloss**] .

3. Epoxy over Self-Priming Epoxy System:

    a. Prime Coat: High build epoxy.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

4. Epoxy, High-Build System:

    a. Prime Coat: Epoxy, anticorrosive primer.
    b. Intermediate Coat: High-build epoxy, matching topcoat.
    c. Topcoat: High-build epoxy.

        1) Gloss Level: [**Low gloss**][**Gloss**] .

5. Epoxy Deck Coating System:

    a. Prime Coat: Epoxy, anticorrosive primer.
    b. Intermediate Coat: Epoxy.
    c. Topcoat: Epoxy deck coating (slip resistant).

6. Epoxy-Modified Latex System:

    a. Prime Coat, First Coat: Water-based, rust-inhibitive primer.
    b. Prime Coat, Second Coat: Water-based, rust-inhibitive primer.
    c. Intermediate Coat: Epoxy-modified latex, matching topcoat.
    d. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

7. Pigmented Polyurethane over Epoxy Primer System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

8. Pigmented Polyurethane over High-Build Epoxy System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: High-build epoxy, low gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

9. Pigmented Polyurethane over Self-Priming Epoxy System:

a. Prime Coat: High-build epoxy.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

10. Pigmented Polyurethane over Inorganic Zinc-Rich and Epoxy System:

a. Prime Coat: Zinc-rich inorganic primer.
b. Intermediate Coat: Epoxy.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

11. Pigmented Polyurethane over Epoxy Zinc-Rich and Epoxy System:

a. Prime Coat: Epoxy zinc-rich primer.
b. Intermediate Coat: Epoxy, gloss.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

B. Galvanized Metal Substrates:

1. Epoxy over Epoxy Primer System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

C. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Epoxy System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Epoxy, gloss.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

D. Copper Substrates:

1. Epoxy System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Epoxy, gloss.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

E. Stainless Steel Substrates:

1. Epoxy System:

    a. Prime Coat: Primer, epoxy.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

    a. Prime Coat: Vinyl wash primer.
    b. Intermediate Coat: Epoxy, gloss.
    c. Topcoat: Pigmented polyurethane.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

3.17 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, WOOD SUBSTRATES

A. Glued-Laminated Wood Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Pigmented polyurethane, matching topcoat.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

B. Exposed Wood-Framed Substrates:

1. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

C. Dressed Wood Substrates: [**Wood trim**][**Architectural woodwork**][**Doors**][**Windows**][**and**][**Wood board paneling**] .

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane.

D. Wood-Traffic Substrates: [**Floors**][**and**][**stairs**] .

1. Clear (Two-Component) Polyurethane System:

a. Prime Coat: Varnish, aliphatic polyurethane, matching topcoat.
b. Intermediate Coat: Varnish, aliphatic polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, .
d. Additive: Manufacturer's standard additive to increase skid resistance of coated surface.

3.18 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, GYPSUM-BASED SUBSTRATES

A. Gypsum Board and Plaster Substrates:

1. Epoxy System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Epoxy, High-Build System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: High-build epoxy, matching topcoat.
c. Topcoat: High-build epoxy.

1) Gloss Level: [**Low gloss**][**Gloss**] .

3. Epoxy-Modified Latex System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3.19 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE, MISCELLANEOUS SUBSTRATES

A. Fiberglass Substrates:

1. Epoxy System:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy.

1) Gloss Level: [**Semigloss**][**Gloss**] .

2. Pigmented Polyurethane System:

a. Prime Coat: Epoxy, gloss.
b. Intermediate Coat: Pigmented polyurethane, matching topcoat.
c. Topcoat: Pigmented polyurethane.

1) Gloss Level: [**Semigloss**][**Gloss**] .

3. Epoxy-Modified Latex System:

    a. Prime Coat: Epoxy-modified latex, matching topcoat.
    b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
    c. Topcoat: Epoxy-modified latex.

        1) Gloss Level: [**Semigloss**][**Gloss**] .

END OF SECTION 09 96 00 00

SECTION 09 96 53 00 - ELASTOMERIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric coating systems.

B. Related Requirements:

1. Section 099113 "Exterior Painting."
2. Section 099600 "High-Performance Coatings" for tile-like coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of elastomeric topcoat product.

C. Samples for Verification: For each type of elastomeric topcoat product indicated and in each color and gloss. Submit [**actual coating system drawdowns as specified below**][**coating manufacturer's standard printed cards**] for verification Samples.

1. Submit Samples on same type of substrate as that to receive application, **8 inches (200 mm)** square.
2. Apply coats on Samples in steps to show each separate coat, including primers and block fillers as applicable.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in the Elastomeric Coating Schedule to cross-reference coating systems specified in this Section. Include color designations.

E. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Environmental Product Declaration (EPD): For each product.
3. Health Product Declaration (HPD): For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[**, from the same production run,**] that match products installed and that are

packaged with protective covering for storage and identified with labels describing contents.

1. Elastomeric Coating System Products: Furnish an additional [**5**]<**Insert number**> percent but not less than [**1 gal. (3.8 L)**]<**Insert quantity**> of each material, color, and texture applied.

1.4 MOCKUPS

A. Apply mockups of each coating system indicated and each color and finish selected to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each coating system.

a. Vertical Surfaces: Provide samples of at least **100 sq. ft (9 sq. m)**.
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between **50 and 90 deg F (10 and 32 deg C)** unless otherwise permitted by manufacturer's written instructions.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

C. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before starting or continuing coating operation.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace

elastomeric coatings that fail within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Water penetration through the coating.
   b. Deterioration of coating beyond normal weathering.
   c. <**Insert failure modes**>.

2. Warranty Period: [**Five**][**10**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each coating system product from single source from single manufacturer.

2.2 ELASTOMERIC COATINGS, GENERAL

A. Elastomeric Coating Systems: Subject to compliance with requirements, [**provide product**][**provide one of the products**][**available products that may be incorporated into the Work include but are not limited to products**] listed in the Elastomeric Coating Schedule Article for the substrate category indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Behr Paint Company (Behr Process LLC)**]
   b. [**Benjamin Moore & Co.**]
   c. [**Coronado Paint; Benjamin Moore & Co.**]
   d. [**Insl-X Products; Benjamin Moore & Co.**]
   e. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
   f. [**Rodda Paint Co.**]
   g. [**Sherwin-Williams Company (The)**]
   h. [**Sto Corp.**]
   i. [**Textured Coatings of America, Inc**]
   j. [**The Pittsburgh Paints Company**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Behr Paint Company (Behr Process LLC)**]
   b. [**Benjamin Moore & Co.**]
   c. [**Coronado Paint; Benjamin Moore & Co.**]
   d. [**Insl-X Products; Benjamin Moore & Co.**]
   e. [**Pratt & Lambert; a subsidiary of The Sherwin-Williams Company**]
   f. [**Rodda Paint Co.**]
   g. [**Sherwin-Williams Company (The)**]
   h. [**Sto Corp.**]
   i. [**Textured Coatings of America, Inc**]

j. [**The Pittsburgh Paints Company**]
k. <**Insert manufacturer's name**>

B. Moisture-Vapor Transmission: Minimum <**Insert perms (metric perms)**>, based on testing in accordance with ASTM D1653.

C. Material Compatibility:

1. Materials for use within each coating system are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a coating system, products are recommended in writing by manufacturers of topcoat for use in elastomeric coating system and on substrate indicated.

D. VOC Content: For field applications, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

E. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As indicated in a color schedule**]<**Insert requirements**>.

1. [**10**][**20**][**30**]<**Insert number**> percent of surface area will be coated with deep tones.

F. Crack Fillers: Elastomeric coating manufacturer's recommended, factory-formulated crack fillers or sealants, including crack filler primers, compatible with substrate and other materials indicated.

G. Primer: Elastomeric coating manufacturer's recommended, factory-formulated, alkali-resistant primer compatible with substrate and other materials indicated.

H. Concrete Masonry Unit Block Filler: Elastomeric coating manufacturer's recommended, factory-formulated, high-performance latex block filler compatible with substrate and other materials indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's requirements for maximum moisture content, alkalinity, and other conditions affecting performance of the Work.

B. Begin coating only when moisture content of substrate is 12 percent or less when measured with an electronic moisture meter.

C. Begin coating no sooner than [**28**]<**Insert number**> days after substrate is constructed and is visually dry on both sides.

D. Verify that substrate is within the range of alkalinity recommended by manufacturer.

E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

F. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Application of coating system indicates acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
2. Perform cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.

D. Crack Repair: Fill cracks in accordance with manufacturer's written instructions before coating surfaces.

3.3 APPLICATION OF ELASTOMERIC COATING SYSTEMS

A. Apply elastomeric coatings in accordance with manufacturer's written instructions.

1. Use equipment and techniques best suited for substrate and type of material being applied.
2. Coat surfaces behind movable items the same as similar exposed surfaces.
3. Apply each coat separately in accordance with manufacturer's written instructions.

B. Primers: Apply at a rate to ensure complete coverage.

C. Block Fillers: Apply at a rate to ensure complete coverage with pores filled.

D. Elastomeric Finish Coat(s): [**Minimum two coats with a total dry film thickness of 16 to 18 mils (0.41 to 0.45 mm)**][**Minimum one coat with a total dry film thickness of 7 to 10 mils (0.18 to 0.25 mm)**][**Manufacturer's recommended number of coats and total dry film thickness for condition of substrate**]<**Insert requirement**>.

E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats similar to color of topcoat, but provide sufficient difference in

shade of undercoats to distinguish each separate coat.

F. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform finish, color, and appearance.

G. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

H. Apply coatings to prepared surfaces as soon as practicable after preparation and before subsequent surface soiling or deterioration.

I. Spray Application: Use spray equipment for application only when permitted by authorities having jurisdiction. Wherever spray application is used, do not double back with spray equipment to build up film thickness of two coats in one pass.

3.4 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following testing procedures:

1. Owner will engage the services of a qualified testing agency to sample materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance of materials with product requirements.
3. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Remove noncomplying materials from Project site, pay for testing, and recoat surfaces that were coated with rejected materials. Remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

B. Field Testing and Inspection: Owner reserves the right to engage the services of a qualified testing agency to verify installed thickness of elastomeric coatings.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities, touch up and restore damaged or defaced coated surfaces.

3.6 ELASTOMERIC COATING SCHEDULE

A. Concrete Substrates:

1. Elastomeric Coating System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Elastomeric, pigmented, exterior, water-based, [**flat**][**nonflat**] coating.

1) <**Insert manufacturer's name; product name or designation**>.

B. Concrete Masonry Unit Substrates:

1. Elastomeric Coating System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Block Filler: As recommended in writing by topcoat manufacturer.
c. Intermediate Coat: As recommended in writing by topcoat manufacturer.
d. Topcoat: Elastomeric, pigmented, exterior, water-based, [**flat**][**nonflat**] coating.

1) <**Insert manufacturer's name; product name or designation**>.

C. Stucco Substrates:

1. Elastomeric Coating System:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Elastomeric, pigmented, exterior, water-based, [**flat**][**nonflat**] coating.

1) <**Insert manufacturer's name; product name or designation**>.

END OF SECTION 09 96 53 00

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Task	Specification	Specification Description
09 96 53 00	09 91 13 00	Exterior Painting
09 96 56 00	09 96 00 00	High-Performance Coatings
09 96 66 00	09 97 26 00	Cementitious Coatings
09 97 13 23	09 96 00 00	High-Performance Coatings
09 97 13 24	09 96 00 00	High-Performance Coatings

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SECTION 09 97 26 00 - CEMENTITIOUS COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and application of cementitious coating systems on the following substrates:

1. [**Exterior**][**Interior**] concrete.
2. [**Exterior**][**Interior**] concrete masonry units.
3. [**Exterior**][**Interior**] brick.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: In each color and gloss of topcoat.

1. Submit Samples on [**rigid backing**][**actual substrate**], not less than **8 inches (200 mm)** square[**, with mortar joint in center**].
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each cementitious coating, from manufacturer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency, for each product formulation.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are from same production run (batch mix) as materials applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Quantity: Furnish an additional [**5**]<**Insert number**> percent of each color applied.

1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of coating system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one [**actual substrate of each type**]<**Insert requirements**> to represent surfaces and conditions for application of coating.

a. Wall Surfaces: Prepare Samples of at least [**100 sq. ft. (9.3 sq. m)**]<**Insert dimension**>.

2. Apply mockups after permanent lighting and other environmental services have been activated.
3. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of colors selected by Architect at no added cost to Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label, and the following information:

1. Product name or title of material.
2. Manufacturer's stock number and date of manufacture.
3. Contents by volume, for pigment and vehicle constituents.
4. Application instructions.
5. Color name and number.
6. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of **45 deg F (7 deg C)**. Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.

1. Protect cementitious coating materials from freezing. Keep materials dry and storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from health hazards resulting from handling, mixing, and applying the coating.

1.7 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 CEMENTITIOUS COATINGS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
2. [**Fox Industries, Inc.**]
3. [**Gemite Products Inc., a W.R. Meadows company**]
4. [**MAPEI Corporation**]
5. [**Master Builders Solutions**]
6. [**Sakrete; CRH Americas, Oldcastle APG**]
7. [**Silpro Corporation**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Euclid Chemical Company (The); a subsidiary of RPM International, Inc.**]
2. [**Fox Industries, Inc.**]
3. [**Gemite Products Inc., a W.R. Meadows company**]
4. [**MAPEI Corporation**]
5. [**Master Builders Solutions**]
6. [**Sakrete; CRH Americas, Oldcastle APG**]
7. [**Silpro Corporation**]
8. <**Insert manufacturer's name**>

C. Products: Subject to compliance with requirements, [**provide product**][**provide one of the products**][**available products that may be incorporated into the Work include, but are not limited to products**] listed in the Cementitious Coating Schedule for the paint category indicated.

D. Source Limitations: Obtain cementitious coating materials from single source and from single manufacturer.

E. Polymer-Modified Cementitious Coating: Containing portland cement, polymer, and hydrated lime or aggregates.

1. Compressive Strength: Not less than [**3500 psi (24.1 MPa)**]<**Insert value**> at 28 days according to ASTM C109/C109M.
2. Tensile Strength: Not less than [**350 psi (2.41 MPa)**]<**Insert value**> at 28 days according to ASTM C109/C109M.
3. Flexural Strength: <**Insert value and test method**>.
4. Adhesion: <**Insert value and test method**>.
5. Permeance: <**Insert value and test method**>.
6. Accelerated Weathering: <**Insert value and test method**>.
7. UV Resistance: <**Insert value and test method**>.
8. Salt-Spray Resistance: <**Insert value and test method**>.
9. <**Insert performance requirements**>.

F. VOC Content, LEED 2009: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.

G. Low-Emitting Materials, LEED 2009: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. VOC Content, LEED v4: For field applications[**that are inside the weatherproofing system**], paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.

I. Low-Emitting Materials, LEED v4: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

J. Material Emissions and Pollutant Control: Not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Flat Coatings: 50 g/L.
    b. Nonflat Coatings: 100 g/L.
    c. Primers, Sealers, and Undercoaters: 100 g/L.

K. Emissions Requirements: Field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Flat Coatings: 50 g/L.
    b. Nonflat Coatings: 100 g/L.
    c. Primers, Sealers, and Undercoats: 100 g/L.

L. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

M. Colors: [**As selected by Architect from manufacturer's full range**][**Match Architect's samples**][**As**

indicated in a color schedule]<**Insert requirements**>.

N. Other Materials: Provide crack fillers, block fillers, and related materials that are compatible with cementitious finish-coat materials and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility.

C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.

D. Cementitious and Masonry Surfaces: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.

1. Cracks Larger Than **1/32 Inch (0.8 mm)**: Cut out static cracks, voids, or honeycombing larger than **1/32 inch (0.8 mm)** and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

3.3 APPLICATION

A. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.

1. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning

application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated and surface dry at time of application.
2. Brushes: Use Tampico or masonry brushes best suited for material being applied.
3. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.

B. Apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:

1. First Coat: Apply polymer-modified cementitious coating material at the rate of **2 lb/sq. yd. (1 kg/sq. m)** to achieve a total cured thickness of **25 mils (0.6 mm)**.
2. Second Coat: Apply polymer-modified cementitious coating material at the rate of **1 lb/sq. yd. (0.5 kg/sq. m)** to achieve a total cured thickness of **15 mils (0.4 mm)**.
3. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.

C. On previously coated surfaces, apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:

1. Apply polymer-modified cementitious coating material at the rate of **1 lb/sq. yd. (0.5 kg/sq. m)** to achieve a total cured thickness of **15 mils (0.4 mm)**.
2. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.

D. Brush Application: Brush out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.

E. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.

3.4 FIELD QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coating operations are being conducted:

1. Owner will engage the services of a qualified testing agency to sample coating materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance with product requirements specified.
3. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing,

scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 CEMENTITIOUS COATING SCHEDULE

A. Above-Grade Concrete and Masonry:

1. Polymer-Modified Cementitious Coating:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Polymer-modified cementitious coating.

1) <**Insert manufacturer's name; product name or designation**>.

END OF SECTION 09 97 26 00

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Task	Specification	Specification Description
09 97 26 13	09 96 00 00	High-Performance Coatings
09 97 26 13	09 97 26 00	Cementitious Coatings
09 97 35 00	09 91 23 00	Interior Painting

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SECTION 09 97 63 00 - COATINGS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes application of coating systems on internal HVAC components and external equipment surfaces, including the following systems:

1. Bake-cured corrosion-resistant coating systems.
2. Air-dried corrosion-resistant coating systems.

1.2 DEFINITIONS

A. Salt Water Acetic Acid Test (SWAAT): A salt fog-spray test of corrosion resistance performed in accordance with ASTM G85, Annex 3.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include Safety Data Sheets, preparation requirements, and application instructions.

B. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Reports:

1. Certification of coating material testing.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: [**1**]<**Insert number**>[**container**][**spray can**] of each material and color applied [**, including base coat and top coat products**].

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in clean, dry, well-ventilated areas with ambient temperatures continuously maintained between **50 and 75 deg F (10 and 24 deg C)**.

1. Keep containers out of direct sunlight; avoid excessive heat and keep from freezing.
2. Maintain containers in clean condition, free of foreign materials and residue.
3. Remove rags and waste from storage areas daily.

1.7 CONDITIONS FOR COATING APPLICATION

A. Comply with manufacturer's recommendations regarding required temperature and humidity ranges during coating application.

PART 2 - PRODUCTS

2.1 CORROSION-RESISTANT COATING SYSTEMS, GENERAL

A. Material Compatibility:

1. Provide materials for application within each coating system that are compatible with one another and with metal substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coating material in coating system, submit compatibility certification from manufacturer of each coating product that products are compatible with substrate base material and with substrate-coating products applied as earlier coats.
3. Products shall be of same manufacturer for each coat in a coating system.

B. Colors: [**Manufacturer's standard**]<**Insert requirements**>.

C. VOC Content, LEED 2009: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials, LEED 2009: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. VOC Content, LEED v4: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.

5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

F. Low-Emitting Materials, LEED v4: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Material Emissions and Pollutant Control: Not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Flat Coatings: 50 g/L.
    b. Nonflat Coatings: 100 g/L.
    c. Nonflat - High-Gloss Coatings: 150 g/L.
    d. Dry-Fog Coatings: 150 g/L.
    e. Industrial Maintenance Coatings: 250 g/L.
    f. Pretreatment Wash Primers: 420 g/L.
    g. Primers, Sealers, and Undercoaters: 100 g/L.
    h. Recycled Coatings: 250 g/L.
    i. Rust-Preventive Coatings: 250 g/L.

H. Emissions Requirements: Field-applied paints and coatings that are inside the weatherproofing system shall comply with either of the following:

1. Low-Emitting Materials: VOC emissions shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
2. VOC content shall not exceed limits of authorities having jurisdiction and the following:

    a. Flat Coatings: 50 g/L.
    b. Nonflat Coatings: 100 g/L.
    c. Primers, Sealers, and Undercoats: 100 g/L.
    d. Shellacs, Clear: 730 g/L.
    e. Shellacs, Pigmented: 550 g/L.

I. VOC Content: For field applications inside the building, wall paints shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Interior Flat Latex Wall Paint: 50 g/L.
2. Interior Nonflat Latex Wall Paint: 150 g/L.

J. VOC Emissions: For field applications inside the building, wall paints shall contain no more than half of the chronic REL of VOCs when tested according to the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.2 BAKE-CURED CORROSION-RESISTANT COATING SYSTEMS

A. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**][**2000**][**3500**][**6000**]<**Insert number**> hours.
2. Cross-Hatch Adhesion: ASTM D3359: [**5B**]<**Insert value**>.
3. SWAAT: ASTM G85: [**1000**][**Insert number**] hours.
4. Cyclic Weathering: ISO 12944-9, [**4200**]<**Insert number**> hours.
5. Mandrel Flexibility: ASTM D522/D522M: [**1/4 inch (6 mm)**][**1/2 inch (13 mm)**]<**Insert value**> without cracking or delamination of film after full cure.
6. Adhesion - Elcometer: ASTM D4541: [**1100 psi (7.6 MPa)**]<**Insert value**>.
7. Impact: ASTM D2794.

    a. Direct Hit: [**70 lb.-in. (7.9 N-m)**][**80 lb.-in. (9.0 N-m)**][**90 lb.-in. (10.2 N-m)**][**100 lb.-in. (11.3 N-m)**]<**Insert value**>.
    b. Reverse Hit: [**20 lb.-in. (2.2 N-m)**][**30 lb.-in. (3.4 N-m)**][**40 lb.-in. (4.5 N-m)**][**50 lb.-in. (5.6 N-m)**]<**Insert value**>.

8. pH Range, 14-Day Liquid Spot Test: [**2.4 to 12.6**][**or**][**3 to 12**][**Insert value**].
9. Dry Heat Resistance: ASTM D2485: [**320 deg F (160 deg C)**][**392 deg F (200 deg C)**]<**Insert value**> maximum.
10. Dry Film Thickness: [**0.5 to 1.2 mils (0.013 to 0.030 mm)**][**0.6 to 1.5 mils (0.015 to 0.038 mm)**]<**Insert thickness range**>.
11. Heat-Transfer Reduction: [**1 percent maximum**]<**Insert value**>.
12. Hardness: ASTM D3363 Pencil Test: [**2B-HB**][**5H-6H**]<**Insert value**>.

B. Bake-Cured Coating for Equipment Serving Food-Preparation Areas: In accordance with NSF 51.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Heresite Protective Coatings**]
    b. [**Modine Manufacturing Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Heresite Protective Coatings**]
    b. [**Modine Manufacturing Company**]
    c. <**Insert manufacturer's name**>

C. Bake-Cured Top Coat:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Heresite Protective Coatings**]
    b. [**Modine Manufacturing Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Heresite Protective Coatings**]
   b. [**Modine Manufacturing Company**]
   c. <**Insert manufacturer's name**>

3. Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.

D. Bake-Cured, Immersion-Applied Phenolic Epoxy System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Heresite Protective Coatings**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Heresite Protective Coatings**]
   b. <**Insert manufacturer's name**>

E. Baked-Cured, Immersion-Applied Epoxy Coating System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Modine Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Modine Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2.3 AIR-DRIED CORROSION-RESISTANT COATING SYSTEMS

A. Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**][**2000**][**3500**]<**Insert number**> hours.
2. Cross-Hatch Adhesion: ASTM D3359: [**5B**]<**Insert value**>.
3. Cyclic Weathering: ISO 12944-9, Offshore Standard: [**4200**]<**Insert number**> hours.
4. Mandrel Flexibility: ASTM D522/D522M: [**1/2 inch (13 mm)**][**1/8 inch (3 mm)**]<**Insert value**> without cracking or delamination of film after full cure.
5. Impact: ASTM D2794.

a. Direct Hit: [**100 in-lb (11.3 N-m)**]<**Insert value**>.

6. Dry Heat Resistance: ASTM D2485: [**356 deg F (180 deg C)**]<**Insert value**> maximum.
7. Dry Film Thickness: [**2 to 3 mils (0.050 to 0.075 mm)**]<**Insert thickness range**>.
8. Heat-Transfer Reduction: [**1 percent**]<**Insert value**> maximum.
9. Hardness: ASTM D3363 Pencil Test: [**2B-HB**][**2H**][**HBF**]<**Insert value**>.

B. Air-Dried, Spray-Applied Principle Coating System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Blygold America**]
   b. [**Heresite Protective Coatings**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Blygold America**]
   b. [**Heresite Protective Coatings**]
   c. <**Insert manufacturer's name**>

C. Air-Dried Phenolic System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Heresite Protective Coatings**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Heresite Protective Coatings**]
   b. <**Insert manufacturer's name**>

D. Air-Dried, Spray-Applied Coating System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Modine Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Modine Manufacturing Company**]
b. <**Insert manufacturer's name**>

E. Air-Dried, Spray-Applied, Polyurethane Mixed with Aluminum Flakes System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blygold America**]
b. [**Energy Guard USA**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blygold America**]
b. [**Energy Guard USA**]
c. <**Insert manufacturer's name**>

F. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**][**2000**][**3000**][**4000**][**5000**][**6000**][**10,000**]<**Insert number**> hours.
2. SWAAT: ASTM G85: [**1000**][**Insert number**] hours.
3. Cyclic Weathering: ISO 12944-9: [**4200**]<**Insert number**> hours.
4. Cross-Hatch Adhesion: ASTM D3359: [**5B**]<**Insert value**>.
5. Mandrel Flexibility: ASTM D522/D522M: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**1/2 inch (13 mm)**]<**Insert value**> without cracking or delamination of film after full cure.
6. Adhesion - Elcometer: ASTM D4541: [**1,100 psi (7.6 MPa)**]<**Insert value**>
7. Impact: ASTM D2794.

a. Direct Hit: [**100 lb.-in. (11.3 N-m)**][**160 lb.-in. (18.0 N-m)**]<**Insert value**>.

8. Dry Heat Resistance: ASTM D2485: [**250 deg F (121 deg C)**]<**Insert value**> maximum.
9. Dry Film Thickness: [**0.5 to 1.2 mils (0.013 to 0.030 mm)**][**0.6 to 1.5 mils (0.015 to 0.038 mm)**]<**Insert thickness range**>.
10. Heat-Transfer Reduction: [**1 percent**]<**Insert value**> maximum.
11. Hardness: ASTM D3363 Pencil Test: [**2B-HB**][**HB-F**]<**Insert value**>.

G. Air-Dried Coating for Equipment Serving Food-Preparation Areas: In accordance with 21 CFR 175.300.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Heresite Protective Coatings**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Heresite Protective Coatings**]
b. <**Insert manufacturer's name**>

H. Spray-Can Application System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Heresite Protective Coatings**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Heresite Protective Coatings**]
b. <**Insert manufacturer's name**>

3. Spray-Can Application System Air-Dried Top Coat Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.

a. Type: Air dry, phenolic.

2.4 SOURCE QUALITY CONTROL

A. Certification of Coating Material Testing: Submit manufacturer's test report of corrosion-resistance performance testing, as performed by a nationally recognized testing laboratory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with coating manufacturer's requirements and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

1. Thinning: Thin coating material with manufacturer's recommended thinning products when recommended or permitted by coating system manufacturer.

B. Comply with coating system manufacturer's recommendations to clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

3.3 APPLICATION

A. Verify with coating manufacturer whether coatings required must be applied and cured in factory-certified application shop.

B. Apply coating systems with equipment designed to deposit coating of specified uniform thickness over HVAC components, in complex, three-dimensional geometries.

1. Apply coatings with manufacturer-recommended tools and techniques suited for specified coating system and each coated HVAC component.
2. Do not apply coatings over labels or equipment name, identification, performance rating, or nomenclature plates.

C. Perform inspection and coating system manufacturer's recommended tests to verify coating integrity and thickness. Where coating was damaged by testing, repair damage in accordance with coating system manufacturer's written recommendations.

END OF SECTION 09 97 63 00

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Task	Specification	Specification Description
09 97 63 00	01 22 00 00	No Specification Required
09 97 63 00	09 96 00 00	High-Performance Coatings

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SECTION 13 46 13 00 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Lightning protection system for ordinary structures.

B. Section Includes: Lightning protection system for the following:

1. Ordinary structures.
2. <**Insert one or more miscellaneous structures or special occupancies**>.

1.2 ACTION SUBMITTALS

A. Product Data: For each product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
    b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. [**UL Master Label Certificate**][**UL Letter of Findings Limited Scope Inspection Report**][**LPI Master Certificate**][**LPI Limited Scope Certification**].

1.5 QUALITY ASSURANCE

A. Installer Qualifications: [**UL-listed installer, category OWAY**][**or**][**LPI Master Installer**].

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION FOR STRUCTURES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**allG Fabrication (formerly ALT)**]
2. [**East Coast Lightning Equipment Inc.**]
3. [**ERICO; brand of nVent Electrical plc**]
4. [**Harger Lightning & Grounding; business of Harger, Inc.**]
5. [**Heary Bros. Lightning Protection Co. Inc**]
6. [**Independent Protection Co**]
7. [**National Lightning Protection**]
8. [**Preferred Lightning Protection**]
9. [**Robbins Lightning, Inc**]
10. [**Thompson Lightning Protection, Inc**]
11. [**VFC Lightning Protection**]
12. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**allG Fabrication (formerly ALT)**]
2. [**East Coast Lightning Equipment Inc.**]
3. [**ERICO; brand of nVent Electrical plc**]
4. [**Harger Lightning & Grounding; business of Harger, Inc.**]
5. [**Heary Bros. Lightning Protection Co. Inc**]
6. [**Independent Protection Co**]
7. [**National Lightning Protection**]
8. [**Preferred Lightning Protection**]
9. [**Robbins Lightning, Inc**]
10. [**Thompson Lightning Protection, Inc**]

11. [**VFC Lightning Protection**]
12. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for [**Class I**][**Class II**] buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for [**Class I**][**Class II**] buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. [**Copper**][**Stainless steel**][**or**][**Aluminum**] unless otherwise indicated.
2. [**3/8-inch (10-mm)**][**1/2-inch (12.7-mm)**][**5/8-inch (16-mm)**] diameter by [**10 inches (254 mm)**][**12 inches (305 mm)**][**15 inches (380 mm)**][**18 inches (450 mm)**][**24 inches (610 mm)**]<**Insert length of air terminal**> long.
3. [**Pointed**][**Rounded**] tip.
4. [**Integral base support**][**Threaded base support**].

B. Air Terminal Bracing:

1. [**Aluminum**][**Copper**][**Stainless steel**][**Galvanized steel**].
2. [**1/4-inch (6-mm)**]<**Insert size**> diameter rod.

C. Class I Main Conductors:

1. [**Stranded Copper: 57,400 circular mils in diameter**][**Aluminum: 98,600 circular mils in diameter**].

D. Class II Main Conductors:

1. [**Stranded Copper: 115,000 circular mils in diameter**][**Aluminum: 192,000 circular mils in diameter**].

E. Secondary Conductors:

1. [**Stranded Copper: 26,240 circular mils in diameter**][**Aluminum: 41,400 circular mils in diameter**].

F. Ground Loop Conductor: [**Stranded copper**][**Tinned copper**].

G. Ground Rods:

1. Material: [**Solid copper**][**Copper-clad steel**][**Stainless steel**].
2. Diameter: [**5/8 inch (16 mm)**][**3/4 inch (19 mm)**].
3. Rods shall be not less than **120 inches (3050 mm)** long.
4. [**Sectional type, with integral threads**].

H. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to [**UL 96A**][**NFPA 780**].

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and **8 inches (203 mm)** in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within **200 feet (60 m)** of building. Comply with requirements for [**concealed installations in UL 96A**][**concealed systems in NFPA 780**].

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: [**bolted connectors**][**exothermic weld**][**high compression**][**crimp**].

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**][**Engage**] a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.

END OF SECTION 13 46 13 00

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SECTION 26 01 00 00 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements generally applicable to all electrical Work on the Project, including but not limited to Work specified in Divisions 26, 27, and 28.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> specifies preinstallation conference procedures.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8P8C: An 8-position 8-contact modular jack.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AGC: Automatic gain control.
6. AIC: Ampere interrupting capacity.
7. AL, Al, or ALUM: Aluminum.
8. ASD: Adjustable-speed drive.
9. ATP: Acceptance test procedure.
10. ATS: Automatic transfer switch.
11. A/V: Audio/visual.
12. AWG: American wire gauge; see ASTM B258.
13. BAS: Building automation system.
14. BDA: Bi-directional amplifier.
15. BIL: Basic impulse insulation level.
16. BIM: Building information modeling.
17. BMS: Building management system.
18. BNC: Bayonet Neill-Concelman - type of connector.
19. B/W: Black and white.
20. CAD: Computer-aided design or drafting.
21. CATV: Community antenna television.
22. CB: Circuit breaker.
23. CCD: Charge-coupled device.
24. CCTV: Closed-circuit television.
25. cd: Candela, the SI fundamental unit of luminous intensity.
26. CO/ALR: Copper-aluminum, revised.
27. COPS: Critical operations power system.
28. CU or Cu: Copper.
29. CU-AL or AL-CU: Copper-aluminum.

30. DACR: Digital alarm communicator receiver.
31. DACT: Digital alarm communicator transmitter.
32. DAS: Distributed antenna system.
33. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
34. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
35. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
36. dBm: Decibel absolute power with respect to 1 mW.
37. dBmV: Decibel absolute voltage with respect to 1 mV across identical impedance.
38. DC or dc: Direct current.
39. DCOA: Designated critical operations area.
40. DDC: Direct digital control (HVAC).
41. DGP: Data gathering panel.
42. DHCP: Dynamic host configuration protocol.
43. EGC: Equipment grounding conductor.
44. ELV: Extra-low voltage.
45. EMF: Electromotive force.
46. EMI: Electromagnetic interference.
47. EMP: Electrical maintenance program (operation and maintenance); electromagnetic pulse (transient analysis).
48. EPS: Emergency power supply.
49. EPSS: Emergency power supply system.
50. ERCES: Emergency responder communications enhancement system.
51. ESS: Energy storage system.
52. EV: Electric vehicle.
53. EVPE: Electric vehicle power export equipment.
54. EVSE: Electric vehicle supply equipment.
55. FACU: Fire-alarm control unit.
56. FAS: Fire-alarm system.
57. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
58. FCC: Federal Communications Commission; fire command center.
59. FLC: Full-load current.
60. ft: Foot.
61. ft-cd: Foot-candle, the antiquated U.S. standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" when the SI unit candela (cd) replaced the international candle; see "fc."
62. FTP: File transfer protocol.
63. FXO: Foreign exchange office.
64. GEC: Grounding electrode conductor.
65. GFCI: Ground-fault circuit interrupter.
66. GFPE: Ground-fault protection of equipment.
67. GND: Ground.
68. GROL: General Radiotelephone Operator License (FCC).
69. H.323: Audio and video protocol.
70. HACR: Heating, air conditioning, and refrigeration.
71. HDPE: High-density polyethylene.
72. HID: High-intensity discharge.
73. HP or hp: Horsepower.
74. HVAC: Heating, ventilating, and air conditioning.
75. Hz: Hertz.
76. I&TFAS: Inspection and testing of fire-alarm system.

77. IB-PSC: In-building public safety communications.
78. IBT: Intersystem bonding termination.
79. ICT: Information and communications technology.
80. IDC: Initiating device circuit.
81. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
82. I/O: Input/output.
83. IP: Ingress protection rating (enclosures); Internet protocol (communications).
84. IR: Infrared.
85. IS: Intrinsically safe.
86. IT&R: Inspecting, testing, and repair.
87. ITE: Information technology equipment.
88. kAIC: Kiloampere interrupting capacity.
89. kcmil or MCM: One thousand circular mils.
90. kV: Kilovolt.
91. kVA: Kilovolt-ampere.
92. kvar: Kilovolt-ampere reactive.
93. kW: Kilowatt.
94. kWh: Kilowatt-hour.
95. LAN: Local area network.
96. lb: Pound (weight).
97. lbf: Pound (force).
98. LCD: Liquid-crystal display.
99. LCDI: Leakage-current detector-interrupter.
100. LED: Light-emitting diode.
101. Li-ion: Lithium-ion.
102. lm: Lumen, the SI-derived unit of luminous flux.
103. LNG: Liquefied natural gas.
104. LP-Gas: Liquefied petroleum gas.
105. LRC: Locked-rotor current.
106. LTE: Long-term evolution (mobile device technology standard).
107. LV: Low voltage.
108. lx: Lux, the SI-derived unit of illuminance equal to one lumen per square meter.
109. m: Meter.
110. MATV: Master antenna television.
111. MCC: Motor-control center.
112. MDC: Modular data center.
113. MG set: Motor-generator set.
114. MIDI: Musical instrument digital interface.
115. MLO: Main lugs only.
116. MPEG: Moving Picture Experts Group.
117. MPEG-2: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard for generic coding of moving pictures and associated audio information (ISO/IEC 13818) released in 1995 and used for most over-the-air and satellite broadcast digital television.
118. MPEG-4: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard framework for coding of audio-visual objects (ISO/IEC 14496) released in 1999, with digital rights management and more advanced compression algorithms than MPEG-2.
119. MOV: Metal-oxide varistor.
120. MV: Medium voltage.
121. MVA: Megavolt-ampere.
122. mW: Milliwatt.
123. MW: Megawatt.
124. MWh: Megawatt-hour.
125. NAC: Notification appliance circuit.
126. N.C.: Normally closed.
127. NFC: Near field communications.
128. Ni-Cd: Nickel-cadmium.

129. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.
130. Ni-MH: Nickel-metal hydride.
131. NIU: Network interface unit.
132. N.O.: Normally open.
133. NPT: National (American) standard pipe taper.
134. NTSC: National Television System Committee.
135. OCPD: Overcurrent protective device.
136. ONT: Optical network terminal.
137. PC: Personal computer.
138. PCS: Power conversion system.
139. PCU: Power-conditioning unit.
140. Percent obs/ft (percent obs/m): Percent obscuration per unit distance; unit of measure for sensitivity of smoke detectors.
141. PF or pf: Power factor.
142. PHEV: Plug-in hybrid electric vehicle.
143. PIR: Passive infrared.
144. PLC: Programmable logic controller.
145. PLFA: Power-limited fire alarm.
146. PoE: Power over Ethernet.
147. POTS: Plain old telephone service. See "public switched telephone network" definition.
148. PSTN: Public switched telephone network.
149. PTZ: Pan-tilt-zoom.
150. PV: Photovoltaic.
151. PVC: Polyvinyl chloride.
152. pW: Picowatt.
153. RAID: Redundant array of inexpensive disks; redundant array of independent disks.
154. RAM: Random-access memory.
155. RAT: Radio alarm transmitter.
156. REX: Request-to-exit.
157. RF: Radio frequency.
158. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
159. RMS or rms: Root-mean-square.
160. RPM or rpm: Revolutions per minute.
161. SCADA: Supervisory control and data acquisition.
162. SCCR: Short-circuit current rating.
163. SCR: Silicon-controlled rectifier.
164. SIP: Session initiation protocol.
165. SLC: Signaling-line circuit.
166. SPD: Surge protective device.
167. SPDT: Single pole, double throw.
168. sq.: Square.
169. SWD: Switching duty.
170. TCP/IP: Transmission Control Protocol/Internet Protocol.
171. TEFC: Totally enclosed fan-cooled.
172. TR: Tamper resistant.
173. TVSS: Transient voltage surge suppressor.
174. UHF: Ultra-high frequency.
175. UL: (standards) UL Standards & Engagement Inc.; (product categories) UL, LLC.
176. UL CCN: UL Category Control Number.
177. UPS: Uninterruptible power supply.
178. USB: Universal serial bus.
179. UTC: Coordinated universal time.
180. UV: Ultraviolet.
181. V: Volt, unit of electromotive force.

182. V(ac): Volt, alternating current.
183. V(dc): Volt, direct current.
184. VA: Volt-ampere, unit of complex electrical power.
185. VAR: Volt-ampere reactive, unit of reactive electrical power.
186. VFC: Variable-frequency controller.
187. VOM: Volt-ohm-multimeter.
188. VoIP: Voice over Internet Protocol.
189. VPN: Virtual private network.
190. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
191. VU: Volume unit.
192. W: Watt, unit of real electrical power.
193. WAN: Wide area network.
194. Wh: Watt-hour, unit of electrical energy usage.
195. WPT: Wireless power transfer.
196. WPTE: Wireless power transfer equipment.
197. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERMC: Electrical rigid metal conduit.
10. ERMC-A: Aluminum electrical rigid metal conduit.
11. ERMC-S: Steel electrical rigid metal conduit.
12. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERMC-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.

37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-FPL/FPLR/FPLP: Metal-clad cable containing FPL, FPLR, or FPLP.
31. MC-HL: Metal-clad cable, hazardous location.
32. MI: Mineral-insulated, metal-sheathed cable.
33. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
34. MV: Medium-voltage cable.
35. NM: Nonmetallic sheathed cable.
36. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
37. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
38. NPLF: Non-power-limited fire-alarm circuit cable.
39. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
40. NPLFR: Non-power-limited fire-alarm circuit riser cable.
41. NUCC: Nonmetallic underground HDPE conduit with conductors.
42. OFC: Conductive optical fiber general-purpose cable.

43. OFCG: Conductive optical fiber general-purpose cable.
44. OFCP: Conductive optical fiber plenum cable.
45. OFCR: Conductive optical fiber riser cable.
46. OFN: Nonconductive optical fiber general-purpose cable.
47. OFNG: Nonconductive optical fiber general-purpose cable.
48. OFNP: Nonconductive optical fiber plenum cable.
49. OFNR: Nonconductive optical fiber riser cable.
50. P: Marine shipboard cable.
51. PLTC: Power-limited tray cable.
52. PLTC-ER: Power-limited tray cable, exposed run.
53. PV: Photovoltaic cable.
54. RHH: (high heat) Thermoset rubber, heat-resistant cable.
55. RHW: Thermoset rubber, moisture-resistant cable.
56. SA: Silicone rubber cable.
57. SE: Service-entrance cable.
58. SER: Service-entrance cable, round.
59. SEU: Service-entrance cable, flat.
60. SIS: Thermoset cable for switchboard and switchgear wiring.
61. TBS: Thermoplastic cable with outer braid.
62. TC: Tray cable.
63. TC-ER: Tray cable, exposed run.
64. TC-ER-HL: Tray cable, exposed run, hazardous location.
65. THW: Thermoplastic, heat- and moisture-resistant cable.
66. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
67. THHW: Thermoplastic, heat- and moisture-resistant cable.
68. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
69. TW: Thermoplastic, moisture-resistant cable.
70. UF: Underground feeder and branch-circuit cable.
71. USE: Underground service-entrance cable.
72. XHH: Cross-linked polyethylene, heat-resistant cable.
73. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations and Acronyms for Electrical Flexible Cord Types:

1. SEO: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
3. SEOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
4. SEOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
6. SJEOW: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
7. SJEOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
8. SJEOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
11. SJOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.

12. SJOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
15. SJTOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
16. SJTOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.
18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
19. SOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.
20. SOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.
23. STOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
24. STOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E. Abbreviations for Communications Spaces:

1. EF: Entrance facility; generally serves campus or building. EF may include an ER.
2. ER: Equipment room; generally serves campus or building.
3. TE: Telecommunications enclosure; generally serves a single tenant or floor.
4. TR: Telecommunications room; generally serves a single tenant or floor.

F. Abbreviations for Communications Facilities:

1. HC: Horizontal cross-connect; also called "floor distributor" (FD).
2. IC: Intermediate cross-connect; also called "building distributor" (BD).
3. MC: Main cross-connect; also called "campus distributor" (CD).

G. Abbreviations for Grounding and Bonding:

1. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
2. PBB: Primary bonding busbar; located in main distribution frame room, ideally near electrical service entrance.
3. RBB: Rack bonding busbar; located in equipment cabinets and racks.
4. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
5. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
6. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
7. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
8. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

H. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."

    a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.

2. Agile Receiver: A broadband receiver that can be tuned to any desired channel.
3. Backbone: Primary segment of ERCES between donor antenna and distribution cabling.
4. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
5. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.
6. Broadcast Media: Loudspeakers, radios, cellular phones, and other media that will carry the selected message to the selected audience.
7. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
8. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, the signal is spread out over a wider band. The carrier frequency is the center frequency on any television channel.
9. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
10. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
11. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
12. Conductive Cable: Cable containing non-current-carrying electrically conductive members such as metallic strength members and metallic vapor barriers.
13. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
14. Conduit: A structure containing one or more duct raceways.
15. Control Unit: A system component that monitors inputs and controls outputs through various types of circuits.

    a. Autonomous Control Unit (ACU): The primary control unit for an in-building mass notification system (MNS).
    b. Emergency Communications Control Unit (ECCU): A system capable of sending mass notification messages to individual buildings, zones of buildings, individual outdoor loudspeaker arrays, or zones of outdoor loudspeaker arrays; or a building, multiple buildings, outside areas, or a combination of these.
    c. Fire-alarm control unit (FACU).
    d. Wireless Control Unit: A component that transmits/receives and processes wireless signals.

16. Designated Seismic System: An architectural, electrical, or mechanical system and its components for which the component importance factor is greater than 1.0 when determined in

accordance with Section 018123 "Facility Seismic and Wind Criteria."

17. Direct Buried: Installed underground without encasement in concrete or other protective material.
18. Downlink: The signal from a base station to portable radios.
19. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
20. Duct Raceway: A single enclosed raceway for conductors or cable.
21. Electrical Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
22. Emergency Communications System (ECS): A system for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action.

    a. Distributed Recipient Mass Notification System (DRMNS): A system meant to communicate directly to targeted individuals and groups that might not be in a contiguous area.
    b. Emergency Voice/Alarm Communications System (EVACS): Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as evacuation signals pertaining to an emergency, to the occupants of a building.
    c. Mass Notification System (MNS): A system used to provide information and instructions to people in buildings or other spaces using intelligible voice communications and including visual signals, text, graphics, tactile, or other communication methods (in-building MNS); and could have the capability to provide real-time information to outdoor areas and to communicate with other notification systems provided for a campus, region, or global geographic setting (wide-area MNS).

23. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that is designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety of human life.
24. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Concrete Box: A box intended for use in poured concrete.
    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
    d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
    e. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
    f. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
    g. Device Box: A box with provisions for mounting a wiring device directly to the box.
    h. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
    i. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
    j. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
    k. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the

entrance of scrub water at the floor level.

l. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
m. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
n. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
o. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
p. Raised-Floor Box: A floor box intended for use in raised floors.
q. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
r. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
s. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
t. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

25. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
26. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.

    a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.

27. Headend: The control center of the MATV system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "central retransmission facility."
28. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
29. High Power Loudspeaker Array (HPLA): A product providing capability for voice and tone communication to large outdoor areas.
30. Jack: Also commonly called an "outlet," it is the fixed, female connector.
31. Jacket: A continuous nonmetallic outer covering for conductors or cables.
32. Local Operator Console (LOC): Equipment used by authorized personnel and emergency responders to activate and operate a mass notification system (MNS).
33. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
34. Master Control Unit: System component that accepts inputs from other control units and may also

perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

35. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
36. Monitoring: Acquisition, processing, communication, and display of system and equipment status data and event and alarm signals.
37. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
38. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
39. Nonsecure: Unlocked or open. (For doors and gates.)
40. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. Also called "single-line diagram."
41. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
42. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
43. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
44. Protective Device: A device that senses when an abnormal current flow, abnormal voltage potential, or other abnormal electrical waveform exists and then disconnects the affected portion of the circuit from the system. Common protective devices include fuses, circuit breakers, relays, ground-fault circuit interrupters, and arc-fault circuit interrupters.
45. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted pair cables from a telephone-provider central office for the transmission medium. "PSTN" refers to the telephone network; "POTS" refers to the individual subscriber line.
46. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
47. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
48. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
49. Secure: Closed and locked and with no unlock or open commands pending. (For doors and gates.)
50. Sheath: A continuous metallic covering for conductors or cables.
51. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
52. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
53. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
54. Uplink: The signal from a portable radio to the base station.
55. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.
56. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
    b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
    c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
    d. Low Voltage (LV): Having electromotive force between any two conductors, or between a

single conductor and ground, that is rated above 30 V but not exceeding 1000 V.

e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.

f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

57. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

58. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.
3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:

    a. Exercising generators.
    b. Emergency lighting.
    c. Elevators.
    d. Fire-alarm systems.

4. Arrange to provide temporary emergency and standby electrical [**service**][**or**][**power**] so facility may remain occupied during the outage in accordance with requirements specified in Section 015000 "Temporary Facilities and Controls." Coordinate power requirements with Owner.

B. Interruption of Existing Telephone Service: Do not interrupt telephone service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of telephone service.
2. Do not proceed with interruption of telephone service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

C. Interruption of Existing Internet Service: Do not interrupt internet service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of internet service.
2. Do not proceed with interruption of internet service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

D. Interruption of Existing Security System: Do not interrupt security system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of security system.
2. Do not proceed with interruption of security system without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

E. Interruption of Existing Fire-Alarm System: Do not interrupt fire-alarm system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of fire-alarm system.
2. Do not proceed with interruption of fire-alarm system without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

1.4 PREINSTALLATION MEETINGS

A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Electrical installation schedule.
2. Status of power system studies.
3. Value analysis proposals and requests for substitution of electrical equipment.
4. Utility work coordination and class of service requests.
5. Commissioning activities.
6. Sustainability activities[**, including Measurement and Verification Plan**].

B. Communications Preconstruction Conference: Schedule conference with Architect and Owner not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Installation schedule for communications systems.
2. Value analysis proposals and requests for substitution of communications equipment.
3. Utility services work coordination and monitoring service requests.
4. Commissioning activities.
5. Sustainability activities.

C. Electronic Safety and Security Preconstruction Conference: Schedule conference with Architect and Owner not later than [**10**]<**Insert number**> days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Installation schedule for security, fire-alarm, and other life-safety systems.
2. Value analysis proposals and requests for substitution of electronic safety and security equipment.
3. Monitoring services work coordination and monitoring service requests.
4. Commissioning activities.
5. Sustainability activities.

1.5 SEQUENCING

A. Conduct and submit results of power system studies before submitting product data and Shop Drawings

for electrical equipment.

1.6 SCHEDULING

A. <**Insert requirements for unusual scheduling coordination**>.

1.7 ACTION SUBMITTALS

A. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.

B. Coordination Drawings for Ceiling Areas: Where indicated on drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment and suspension systems will be attached.
3. Size and location of access panels on ceilings.
4. Elevation, size, and route of sprinkler piping.
5. Elevation, size, and route of plumbing piping.
6. Elevation, size, and route of ductwork.
7. Elevation, size, and route of cable tray.
8. Elevation, size, and route of conduit.
9. Elevation and size of wall-mounted and ceiling-mounted equipment.
10. Access panels.
11. Sprinklers.
12. Air inlets and outlets.
13. Control modules.
14. Luminaires.
15. Communications devices.
16. Speakers.
17. Security devices.
18. Fire-alarm devices.
19. Indicate clear dimensions for maintenance access in front of equipment.
20. Indicate dimensions of fully open access doors.

C. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Elevation, size, and route of cable trays.
2. Relationships between components and adjacent structural, electrical, and mechanical elements.
3. Vertical and horizontal offsets and transitions.
4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
5. Elevation of ceilings and size of ceiling tiles.
6. Locations of access panels on ceilings.
7. Locations where cable tray crosses or parallels sprinkler piping.
8. Locations where cable tray crosses plumbing piping.
9. Locations where cable tray crosses or parallels ductwork.
10. Locations of access panels on ductwork.
11. Locations where cable tray crosses conduit.

12. Items blocking access around cable trays, including the following:

    a. Light fixtures.
    b. Speakers.
    c. Fire-alarm devices.
    d. Power outlets.
    e. Wall-mounted equipment.
    f. Equipment racks.
    g. Furniture.
    h. Door swings.
    i. Building features.

13. Indicate clear dimension between cable tray and walls or obstructions that are closer than **10 ft (3 m)**.
14. Highlight locations where cable tray is greater than **3 ft (1 m)** above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.

D. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

E. Coordination Drawings for Bus Assembly Routing: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements.
2. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
3. Clearances for access above and to the side of enclosed bus assemblies.
4. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
5. Support locations, type of support, and weight on each support.
6. Location of adjacent construction elements, including luminaires, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

F. Coordination Drawings for Large Equipment Indoor Installations:

1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

    a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
    b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
    c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.

3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways[**, busways,**][**and seismic bracing**].
b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.

G. Coordination Drawings for Large Equipment Outdoor Installations:

1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
b. Indicate clear dimensions for fence gates and wall openings.
c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways[**, busways,**][**and seismic bracing**].
f. Dimensioned working clearances and dedicated areas around electrical equipment.

H. Coordination Drawings for Duct Banks:

1. Show duct profiles and coordination with other utilities and underground structures.
2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

I. Sustainable Design Submittals:

1. Electrical Waste Management (Wire): Provide documentation for quantity of abandoned electrical wire that has been removed from Project site, in accordance with Rule 645.5(G) of NFPA 70, and provide verification that abandoned wire containing lead stabilizers has been identified and disposed of in accordance with jurisdictional hazardous waste requirements.
2. Electrical Waste Management (Lamps): Provide documentation that an area has been provided to serve entire Project for collection and storage of fluorescent and HID lamps and ballasts for their appropriate disposal or recycling in accordance with jurisdictional hazardous waste requirements.
3. Electrical Waste Management (Electronics and Batteries): Provide documentation that an area has been provided to serve entire Project for collection and storage of electronics, alkaline batteries, and rechargeable batteries for their appropriate disposal or recycling in accordance with jurisdictional hazardous waste requirements.

1.8 INFORMATIONAL SUBMITTALS

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 26.
4. Orders placed for major electrical equipment.

5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Utility service outages.
8. Utility service inspection and activation.
9. Mockup reviews.
10. Closing of walls and ceilings containing electrical Work.
11. System startup, testing, and commissioning activities for major electrical equipment.
12. System startup, testing, and commissioning activities for emergency lighting.
13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

B. Installation Schedule for Communications Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of the communications Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 27.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 27.
6. Telephone and internet service outages.
7. Telephone and internet service inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the communications Work.
10. System startup, testing, and commissioning activities for communications equipment.
11. System startup, testing, and commissioning activities for the Work specified in other divisions that depends on the Work specified in Division 27.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.
14. Requests for inspections by authorities having jurisdiction.

C. Installation Schedule for Security, Fire-Alarm, and Other Life-Safety Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of security, fire-alarm, and the other life-safety Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 28.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 28.
6. Security and fire-alarm system outages.
7. Security and fire-alarm system inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the security and fire-alarm Work.
10. System startup, testing, and commissioning activities for security and fire-alarm equipment.
11. System startup, testing, and commissioning activities for fire-alarm interfaces with the Work specified in other divisions.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.

14. Requests for inspections by authorities having jurisdiction.

D. Welding certificates.

E. Seismic Performance Certificates: Provide special certification for designated seismic systems as required to meet requirements specified in Section 018123 "Facility Seismic and Wind Criteria" for all designated seismic systems identified on the Drawings or in the Specifications.

1. Include the following information:

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
d. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
e. Equipment manufacturer's written certification for each designated active electrical seismic device and system, stating that it will remain operable following the basis-of-design seismic criteria specified in Section 018123 "Facility Seismic and Wind Criteria."
f. Equipment manufacturer's written certification that components with hazardous contents maintain containment following the basis-of-design seismic criteria specified in Section 018123 "Facility Seismic and Wind Criteria."
g. Evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by qualified structural professional engineer.

F. Wind Performance Certificates: Provide special certification for systems and components designated on the Drawings or in the Specifications to be subject to high wind exposure and impact damage.

1. Include the following information:

a. Provide equipment manufacturer's written certification for each designated system and component, stating that it will remain in place and operable following the design wind event and comply with requirements of authorities having jurisdiction.
b. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

G. Qualification Statements:

1. For qualified regional manufacturer.
2. For structural professional engineer.
3. For electrical professional engineer.
4. For lighting professional engineer.
5. For EPM specialist.
6. For welder.
7. For ERMC-S-PVC raceway Installer.
8. For medium-voltage cable Installer.
9. For medium-voltage duct Installer.
10. For medium-voltage equipment Installer.
11. For electrical power monitoring Installer.
12. For switchboard Installer.
13. For EVSE Installer.
14. For generator set Installer.
15. For lightning protection system Installer.

16. For theatrical lighting Installer.
17. For exterior athletic lighting Installer.
18. For power quality specialist.
19. For electrical testing and inspecting agency and its on-site electrical testing supervisor.
20. For structural testing and inspecting agency.
21. For outdoor pole testing and inspecting agency.
22. For luminaire photometric testing laboratory.
23. For lighting testing and inspecting agency.
24. For communications design professional.
25. For communications cable Installer.
26. For communications testing and inspecting agency and its on-site communications testing supervisor.
27. For nurse call/code blue system Installer.
28. For security design professional.
29. For fire-alarm system design professional.
30. For mass notification design professional.
31. For IB-PSC design professional.
32. For general radiotelephone operator license (GROL) designer.
33. For emergency communications design professional.
34. For fire-alarm cable Installer and its on-site fire-alarm cable installation supervisor.
35. For security testing and inspecting agency and its on-site security testing supervisor.
36. For intrusion detection systems installer.
37. For perimeter security systems integrator.
38. For fire-alarm testing agency and its on-site fire-alarm testing supervisor.
39. For detention electronics systems Installer.
40. For detention electronics systems integrator.
41. For detention electronics systems testing and inspecting agency.

1.9 CLOSEOUT SUBMITTALS

A. Facility EMP Binders:

1. Complete Set: On [**approved online or cloud solution**][**and**][**USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement**].
2. Volumes 2 and 8: Reproducible hardcopy on archival quality, **28 lb (105 GSM)**, acid-free, bond paper.

B. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:

   a. <**Insert system, equipment, or device**>.

2. Include the following information:

   a. Manufacturer's operating specifications.
   b. User's guides for software and hardware.
   c. Schedule of maintenance material items recommended to be stored at the Project site.
   d. Detailed instructions covering operation under both normal and abnormal conditions.
   e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
   f. List of load-current and overload-relay heaters with related motor nameplate data.
   g. List of lamp types and photoelectric relays used on the Project, with ANSI and

manufacturers' codes.
h. Manufacturer's instructions for setting field-adjustable components.
i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
k. Exterior pole inspection and repair procedures.

C. Software and Firmware Operational Documentation: Provide software and firmware operational documentation[**in Facility EPM Binders**], including the following:

1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.
6. For lighting controls, include the following:

a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
b. Operation of adjustable zone controls.

D. Software:

1. Program Software Backup: Provide [**username and password for approved online or cloud solution**][**and**][**USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement**].
2. Provide to Owner upgrades and unrestricted licenses[**for Government use**] for installed and backup software, including operating systems and programming tools required for operation and maintenance.

1.10 MOCKUPS

A. Simple Mockups for Coordinating Accessibility of Electrical Devices around Fixed Furnishings and Equipment:

1. Build simple mockups using art supplies and other inexpensive materials for verification of general arrangement, actual dimensions, and accessibility of <**Insert identification of room and fabrication**> by [**Architect**][**Owner**][**Tenant**]<**Insert approving stakeholders**> prior to fabrication and installation of Work. Depict products from all Divisions requiring coordination, including, but not limited to, fixed furnishings, casework, outlet covers and plates, HVAC controls, exposed raceway, exposed plumbing, equipment, and signage.

B. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the

Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

2.2 SUBSTITUTION LIMITATIONS FOR COMMUNICATIONS EQUIPMENT

A. Substitution requests for communications equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Communications Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Communications Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

2.3 SUBSTITUTION LIMITATIONS FOR ELECTRONIC SAFETY AND SECURITY EQUIPMENT

A. Substitution requests for electronic safety and security equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electronic Safety and Security Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Electronic Safety and Security Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

2.4 FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP) BINDERS

A. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EMP development.

B. Applicable Standards:

1. Regulatory Requirements: Comply with requirements in NFPA 70B.
2. General Characteristics:

a. Volume 1 - Introduction:

1) Summarize how Facility EMP analysis was performed, how data were collected, and how volumes are organized.
2) Describe Facility EMP and provide recommended policies and procedures for implementing the program and keeping it current.
3) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EMP.

b. Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:

1) Include training requirements for employees and contractors.
2) Include list of known facility hazards impacting IT&R activities.
3) Include approval and permitting procedures for IT&R activities.
4) Include incident emergency response procedures.
5) Include emergency shutdown procedures.
6) Include electrical disaster recovery procedures.
7) Include procedures for investigating the following incidents:

a) Electrical safety incidents.
b) Equipment malfunctions.
c) Unintended operations or alarms.
d) Operation of protective devices.

c. Volume 3 - Operating Procedures for Electrical Equipment and Controls:

1) <**Insert requirements**>.

d. Volume 4 - Facility Diagrams and Schedules:

1) Include single-line diagrams.
2) Include grounding and bonding diagrams.
3) Include essential wiring diagrams.
4) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
5) Include records of switchgear, switchboard, and panelboard schedules.
6) Include time-current curves for overcurrent protective devices.
7) Include list of load-current and overload-relay heaters with related motor nameplate data.

e. Volume 5 - Inventory of Facility Equipment Using Electrical Power:

1) Include simplified floor plans showing equipment locations.
2) Identify critical equipment (electrical or otherwise).
3) Include identifying designations and nameplate data.
4) Include warranty and maintenance contract information.

f. Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:

1) Include schedules of maintenance material items recommended to be stored at facility.
2) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
3) Include calibration and servicing data for each item.

g. Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:

1) Include tables showing frequency of activities for each item.
2) Include annual schedule with activities mapped to specific days of the year.
3) Include exterior pole inspection and repair procedures.

h. Volume 8 - Inspection, Testing, and Repair (IT&R) Forms:

1) <**Insert requirements**>.

i. Volume 9 - Inspection, Testing, and Repair (IT&R) Procedures:

1) **<Insert requirements>**.

j. Volume 10 - Spare Parts List:

1) Include list of all parts required to perform IT&R procedures.
2) Identify quantities of which parts are recommended to be stored on-site.
3) Include source contact information and budget cost for each item.

k. Volume 11 - Construction Project Closeout Record Documentation:

1) Include records of power system studies and photometric studies.
2) Include records of risk assessment studies.
3) Include records of electrical system startup and commissioning activities.
4) Include records of baseline inspections and tests.
5) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.
6) Include records of baseline settings for adjustable equipment and devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. **<Insert Project requirements>**.

B. Preinstallation Testing:

1. **<Insert Project requirements>**.

C. Evaluation and Assessment:

1. **<Insert Project requirements>**.

3.2 PREPARATION

A. Protection of In-Place Conditions:

1. **<Insert Project requirements>**.

3.3 DEVELOPMENT OF FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP)

A. Facility EMP must be developed by qualified EMP specialist.

B. Conduct Facility EMP analysis in accordance with NFPA 70B requirements.

1. Renovation Projects:

a. Facility diagrams must include connected existing equipment for entire facility where

known. Areas of uncertainty should be clearly indicated.

b. Obtain copies of existing operation and maintenance data and existing Facility EMP information from Owner.

c. Facility EMP analysis should identify existing equipment that does not have available operation and maintenance data, and should explain Owner's risks because this equipment is not included in Facility EMP.

d. Data for existing equipment outside scope of the Project may be inserted in Facility EMP Binders without analysis.

e. Data for existing equipment impacted by scope of the Project should be analyzed and documented similar to the Project's new equipment data as much as possible.

C. Compile operation and maintenance data from Facility EMP analysis and submit [**updated**] Facility EMP Binders.

3.4 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of electrical Work on the Project. Consult Architect for resolution of conflicting requirements.

3.5 CLEANING

A. Electrical or Electronic Waste Management:

1. <**Insert requirements for special handling or diversion of electrical and electronics waste for recycling or disposal**>.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

   a. How to implement [**updated**] Facility EMP.
   b. <**Insert system or equipment**>.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

END OF SECTION 26 01 00 00

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Task	Specification	Specification Description
26 01 10 00	26 01 00 00	Supplemental Requirements for Electrical
26 01 10 91	26 01 00 00	Supplemental Requirements for Electrical
26 01 20 00	26 01 00 00	Supplemental Requirements for Electrical
26 01 20 91	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 00	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 51	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 51	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 52	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 52	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 53	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 01 50 53	26 01 00 00	Supplemental Requirements for Electrical
26 01 50 81	26 01 00 00	Supplemental Requirements for Electrical

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SECTION 26 05 00 00 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Sealants.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
3. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of raceways, electrical power cabling, and communications cabling referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 270528 "Pathways for Communications Systems" [**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Advance Products & Systems, LLC**]
    b. [**CCI Piping Systems**]
    c. [**Flexicraft Industries**]
    d. [**GPT Industries, LLC.**]
    e. [**Specified Technologies Inc.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Advance Products & Systems, LLC**]
    b. [**CCI Piping Systems**]
    c. [**Flexicraft Industries**]
    d. [**GPT Industries, LLC.**]
    e. [**Specified Technologies Inc.**]
    f. <**Insert manufacturer's name**>

3. Standard Features:

    a. Referenced Standard: ASTM A53/A53M, Type E, Grade B.
    b. Dimensions: Schedule 40; sized so outer diameter of sleeve matches inner diameter of penetration hole.
    c. Corrosion Resistance: Coated with [**Zinc**][**or**][**Gal-vo-plast**] .
    d. Configuration: Plain ends and integral waterstop.

B. Cast-Iron Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**American Cast Iron Pipe Company**]
    b. [**Flexicraft Industries**]
    c. [**McWane Ductile; a part of the McWane family of companies**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Cast Iron Pipe Company**]
    b. [**Flexicraft Industries**]
    c. [**McWane Ductile; a part of the McWane family of companies**]
    d. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe.
b. Configuration: Plain ends and integral waterstop.

C. PVC Pipe Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**CCI Piping Systems**]
b. [**GPT Industries, LLC.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CCI Piping Systems**]
b. [**GPT Industries, LLC.**]
c. [**Metraflex Company (The)**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Referenced Standard: ASTM D1785.
b. Dimensions: Schedule 40.

D. PVC Molded Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**American Polywater Corporation**]
c. [**Arlington Industries, Inc.**]
d. [**Reliance Worldwide Corporation**]
e. [**Roxtec Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**American Polywater Corporation**]
c. [**Arlington Industries, Inc.**]
d. [**Reliance Worldwide Corporation**]
e. [**Roxtec Inc.**]
f. <**Insert manufacturer's name**>

3. Standard Features: With nailing flange for attaching to wooden forms.

E. PE or PP Molded Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**American Polywater Corporation**]
   b. [**Crete-Sleeve**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**American Polywater Corporation**]
   b. [**Crete-Sleeve**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Round, Galvanized-Steel, Sheet Metal Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Benefast**]
   b. [**Specified Technologies Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Benefast**]
   b. [**Specified Technologies Inc.**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Galvanized-steel sheet; thickness not less than **0.0239 inch (0.6 mm)**; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Abesco Fire LLC**]
b. [**Specified Technologies Inc.**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Abesco Fire LLC**]
b. [**Specified Technologies Inc.**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Material: Galvanized sheet steel.
b. Minimum Metal Thickness:

1) For sleeve cross-section rectangle perimeter less than **50 inch (1270 mm)** and with no side larger than **16 inch (400 mm)**, thickness must be **0.052 inch (1.3 mm)**.
2) For sleeve cross-section rectangle perimeter not less than **50 inch (1270 mm)** or with one or more sides larger than **16 inch (400 mm)**, thickness must be **0.138 inch (3.5 mm)**.

2.3 SLEEVE-SEAL SYSTEMS

A. Sleeve-Seal System:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Advance Products & Systems, LLC**]
b. [**American Polywater Corporation**]
c. [**BWM Company**]
d. [**CALPICO, Inc.**]
e. [**Flexicraft Industries**]
f. [**GPT Industries, LLC.**]
g. [**Metraflex Company (The)**]
h. [**Proco Products, Inc**]
i. [**Roxtec Inc.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advance Products & Systems, LLC**]
b. [**American Polywater Corporation**]
c. [**BWM Company**]
d. [**CALPICO, Inc.**]
e. [**Flexicraft Industries**]

f. [**GPT Industries, LLC.**]
g. [**Metraflex Company (The)**]
h. [**Proco Products, Inc**]
i. [**Roxtec Inc.**]
j. <**Insert manufacturer's name**>

3. Standard Features:

a. Modular Sealing Device: Designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
b. Sealing Elements: [**EPDM**][**Nitrile (Buna N)**] rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
c. Pressure Plates: [**Carbon steel**][**Fiber-reinforced plastic**][**Stainless steel**] .
d. Connecting Bolts and Nuts: [**Carbon steel, with corrosion-resistant coating,**][**Stainless steel,**] of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Sleeve-Seal Fitting:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Holdrite; a division of Reliance Worldwide Corporation**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Holdrite; a division of Reliance Worldwide Corporation**]
b. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall.
b. Waterstop Collar: Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Grout for Sealing Penetrations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Specified Technologies Inc.**]
b. [**W. R. Meadows, Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Specified Technologies Inc.**]
b. [**W. R. Meadows, Inc**]
c. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Nonshrinking grout; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
b. Referenced Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
c. Design Mix: **5000 psi (34.5 MPa)**, 28-day compressive strength.
d. Packaging: Premixed and factory packaged.

2.6 SEALANTS

A. Pourable Sealants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Carlisle SynTec Systems; a Carlisle Company**]
b. [**GAF**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Specified Technologies Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Carlisle SynTec Systems; a Carlisle Company**]
b. [**GAF**]
c. [**Johns Manville; a Berkshire Hathaway company**]
d. [**Specified Technologies Inc.**]
e. <**Insert manufacturer's name**>

3. Standard Features:

a. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
b. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

4. Sustainability Characteristics:

    a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.

B. Foam Sealants:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Innovative Chemical Products (Building Solutions Group)**]
    b. [**The Dow Chemical Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Innovative Chemical Products (Building Solutions Group)**]
    b. [**The Dow Chemical Company**]
    c. <**Insert manufacturer's name**>

3. Standard Features:

    a. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
    b. Foam Expansion: Must not damage cables or crack penetrated structure.

4. Sustainability Characteristics:

    a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Communications Work: BICSI N1.

8. Work in ITE Rooms: NFPA 75.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies: Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Interfaces with Other Work:

1. Identification: Provide labels for penetrations and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Grounding and Bonding:

a. Bonding of Metal Sleeve for Metal Raceway Penetrations: Bond metal raceway to metal sleeve on both sides of penetration.
b. Bonding of Metal Sleeve for Cable Penetrations: Bond equipment grounding conductor for electrical power cables, or cable shield for communications cables, to metal sleeve on both sides of penetration.
c. Bonding is not required for nonmetallic sleeves.
d. Grounding of communications cables entering buildings from outside must be provided at the penetration.

3. Hangers and Supports:

a. Support of Raceways and Cables in Sleeve: Comply with manufacturer's published instructions for supporting raceways or cables on both sides of penetration. Sleeve sealing products are typically not rated for supporting the weight of raceways and cables.

3.2 INSTALLATION OF ROUND SLEEVES

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide [**1/4 inch (6.4 mm)**]<**Insert dimension**> annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed [**or seismic criteria require different clearance**] .

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors [2 inch (50 mm)]<**Insert dimension**> above finished floor level. Install sleeves during erection of floors.
6. Seal space outside of sleeves with approved joint compound for wall assemblies.

B. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

C. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [**steel**][**cast-iron**] pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

D. Underground, Exterior-Wall and Floor Penetrations:

1. Install [**steel**][**cast-iron**] pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch (25 mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for 1 inch (25 mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.3 INSTALLATION OF RECTANGULAR SLEEVES

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 26 05 00 00

SECTION 26 05 13 00 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cables.
2. Connectors.
3. Solid terminations.
4. Separable insulated connectors.
5. Splice kits.
6. Medium-voltage tapes.
7. Arc-proofing materials.
8. Fault indicators.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

B. Samples: **16 inch (400 mm)** lengths for each type of cable specified.

C. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For solvents and adhesives, indicating VOC content.
3. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate location of each cable, splice, and termination.

B. Material Certificates: For each type of cable and accessory.

C. Design Data: Cable pulling calculations, including conduit size and fill percentage, pulling tensions, cable sidewall pressure, jam probability, voltage drop, and ground wire sizing for each cable.

D. Source quality-control reports.

E. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**General Cable; Prysmian Group North America**]
2. [**Hendrix Wire and Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
3. [**Kerite Power Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
4. [**Okonite Company (The)**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Southwire Company, LLC**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**General Cable; Prysmian Group North America**]
2. [**Hendrix Wire and Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
3. [**Kerite Power Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.**]
4. [**Okonite Company (The)**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Southwire Company, LLC**]
7. <**Insert manufacturer's name**>

C. Cable Type: [**Type MV 90**][**Type MV 105**].

D. Conductor Insulation: [**Crosslinked polyethylene**][**Ethylene-propylene rubber**].

1. Voltage Rating: [**5**][**8**][**15**][**25**][**35**] kV.
2. Insulation Thickness: [**100**][**133**] percent insulation level.

E. Conductor: [**Copper**][**Aluminum**].

F. Comply with UL 1072, AEIC CS8[**, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682**][**, and ICEA S-94-649**].

G. Conductor Stranding: [**Compact round, concentric lay, Class B**][**Concentric lay, Class B**].

H. Strand Filling: Conductor interstices are filled with impermeable compound.

I. Lead Content: Less than 300 parts per million.

J. Shielding: [**Copper tape**][**Solid copper wires**], helically applied over semiconducting insulation shield.

K. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

L. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together[**with ground conductors**].

1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

M. Cable Sheath: [**Interlocked aluminum**][**Interlocked galvanized steel**][**Corrugated aluminum tube**] applied over cable.

N. Cable Jacket: [**Sunlight-resistant PVC**][**Chlorosulfonated polyethylene**].

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**G&W Electric Company**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**G&W Electric Company**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

D. Copper-Conductor Connectors: [**Copper barrel crimped**][**Aluminum barrel crimped**][**Copper shear bolt**] connectors.

2.4 SOLID TERMINATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**G&W Electric Company**]
5. [**Shawflex; Shawcor Ltd.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**G&W Electric Company**]
5. [**Shawflex; Shawcor Ltd.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal-body, metal-clad cable terminator for metal-clad cable [**with**][**without**] external plastic jacket.
2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
3. Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
4. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.

D. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations:

    a. Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.
    b. Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
    c. Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
    d. Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

2. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape; cold-shrink-rubber sleeve; or heat-shrink, plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
3. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Richards Manufacturing Co.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Richards Manufacturing Co.**]
4. <**Insert manufacturer's name**>

D. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

E. Load-Break Cable Terminators: Elbow-type units with 200 A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

F. Dead-Break Cable Terminators: Elbow-type unit with [**200 A**][**600 A**] continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

G. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

H. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

I. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 SPLICE KITS

A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**Richards Manufacturing Co.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**ABB, Electrification Business**]
3. [**DSG-Canusa; Shawcor Ltd.**]
4. [**Eaton**]
5. [**Richards Manufacturing Co.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

D. Standard: Comply with IEEE 404.

E. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink-rubber, in-line splicing kit.
4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
5. Separable multiway splice system with all components for the required splice configuration.

2.7 MEDIUM-VOLTAGE TAPES

A. Description: Electrical grade, insulating tape rated for medium voltage application.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**HellermannTyton**]
3. [**Scapa Industrial; Scapa Group plc**]

4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**HellermannTyton**]
3. [**Scapa Industrial; Scapa Group plc**]
4. <**Insert manufacturer's name**>

D. Ethylene/propylene rubber-based, **30 mil (0.76 mm)** splicing tape, rated for 130 deg C operation. Minimum **3/4 inch (20 mm)** wide.

E. Silicone rubber-based, **12 mil (0.30 mm)** self-fusing tape, rated for 130 deg C operation. Minimum **1-1/2 inch (38 mm)** wide.

F. Insulating-putty, **125 mil (3.175 mm)** elastic filler tape. Minimum **1-1/2 inch (38 mm)** wide.

2.8 ARC-PROOFING MATERIALS

A. Description: Fire retardant, providing arc flash protection.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. <**Insert manufacturer's name**>

D. Tape for First Course on Metal Objects: **10 mil (250 micrometer)** thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

E. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to **0.3 inch (8 mm)** thick, and compatible with cable jacket.

F. Glass-Cloth Tape: Pressure-sensitive adhesive type, **1 inch (25 mm)** wide.

2.9 FAULT INDICATORS

A. Indicators: [**Automatically**][**Manually**] reset fault indicator[**with inrush restraint feature**], arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.10 SOURCE QUALITY CONTROL

A. Test and inspect cables according to [**ICEA S-97-682**][**ICEA S-94-649**] before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of **5 psig (35 kPa)**.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by **48 to 72 inch (1200 to 1800 mm)** on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

F. Install direct-buried cables on leveled and tamped bed of **3 inch (75 mm)** thick, clean sand. Separate cables crossing other cables or piping by a minimum of **2 inch (50 mm)** of tamped earth, plus an additional **2 inch (50 mm)** of sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

G. Install "buried-cable" warning tape **12 inch (305 mm)** above cables.

H. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

I. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

J. Install cable splices at pull points and elsewhere as indicated; use standard kits.[**Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.**]

K. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

L. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

M. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with **10 mil (250 micrometer)** pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with two layers of **1 inch (25 mm)** wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

N. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."

O. Install fault indicators on each phase where indicated.

P. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

Q. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

R. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 05 13 00

Task	Specification	Specification Description
26 05 13 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 13 16	26 05 13 00	Medium-Voltage Cables
26 05 13 16	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 13 16	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 19 00 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-insulated wire.
2. Thermoset-insulated wire.
3. Nonmetallic underground conduit with conductors.
4. Metallic sheathed cable.
5. Photovoltaic single-conductor cable.
6. Nonmetallic jacketed cable.
7. Connectors and splices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.
6. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260533.13 "Conduits for Electrical Systems" specifies installation of raceways referenced by this Section.
10. Section 260536 "Cable Trays for Electrical Systems" specifies cable tray installation referenced by this Section.
11. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling" specifies installation of sleeves and sleeve seals referenced by this Section.
12. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
13. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
14. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.2 DEFINITIONS

A. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

1.3 ACTION SUBMITTALS

A. Product Schedule: Indicate type, use, location, and termination locations.

B. Product Data: For each type of product.

C. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For recycled content, indicating percentage of postconsumer and preconsumer recycled content and cost.
3. Product Data: For solvents and adhesives, indicating VOC content.
4. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Field reports for infrared scanning.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 THERMOPLASTIC-INSULATED WIRE

A. Description: Thermoplastic-insulated wire for use in accordance with Article 310 of NFPA 70.

B. UL ZLGR - Type THHN Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 90 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to

gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

C. UL ZLGR - Type THHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: [**75 deg C**][**90 deg C**].
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.

g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

D. UL ZLGR - Type THW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Service Wire Co.**]
h. [**Southwire Company, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Service Wire Co.**]
h. [**Southwire Company, LLC**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: [**75 deg C**][**90 deg C**].
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.

e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

E. UL ZLGR - Type THW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Service Wire Co.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Service Wire Co.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

F. UL ZLGR - Type THWN Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Cerro Wire LLC**]
d. [**Encore Wire Corporation**]
e. [**Okonite Company (The)**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 75 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

G. UL ZLGR - Type THWN-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
    b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    g. Marked "VW-1," indicating compliance with special vertical flame test.
    h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

H. UL ZLGR - Type TW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Service Wire Co.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alpha Wire; brand of Belden, Inc.**]
    b. [**Belden Inc.**]
    c. [**Cerro Wire LLC**]
    d. [**Encore Wire Corporation**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Service Wire Co.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 60 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].

e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

I. UL ZLGR - Type FEP Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Covering: None.
c. Insulation Voltage Rating: 600 V.
d. Insulation Temperature Rating: 90 deg C for dry and damp locations.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

J. UL ZLGR - Type FEPB Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Covering: Glass or other suitable braid material.
c. Insulation Voltage Rating: 600 V.
d. Insulation Temperature Rating: 200 deg C for dry locations.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

K. UL ZLGR - Type Z Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**90 deg C for dry and damp locations**][**150 deg C for dry locations and special applications**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.

b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

L. UL ZLGR - Type ZW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Okonite Company (The)**]
   c. [**Prysmian Cables and Systems; Prysmian Group North America**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**60 deg C**][**75 deg C**][**85 deg C**][**90 deg C**][**150 deg C**][**200 deg C**][**250 deg C**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to

gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

M. UL ZLGR - Type ZW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Okonite Company (The)**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Okonite Company (The)**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

      1) Thermoplastic Fluoropolymer Wire: Also investigated in accordance with UL 83A.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: [**75 deg C for wet locations**][**90 deg C for dry and damp locations**][**150 deg C for dry locations and special applications**].
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   f. Marked "VW-1," indicating compliance with special vertical flame test.
   g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

N. UL ZLGR - Type TBS Insulated Switchboard Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Prysmian Cables and Systems; Prysmian Group North America**]
    c. [**Southwire Company, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Prysmian Cables and Systems; Prysmian Group North America**]
    c. [**Southwire Company, LLC**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

        1) Thermoplastic and Fibrous Outer Braid: Also investigated in accordance with UL 83B.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    f. Marked "VW-1," indicating compliance with special vertical flame test.
    g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

O. UL ZLGR - Thermoplastic-Insulated Submersible Pump Multiconductor Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cerro Wire LLC**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cerro Wire LLC**]
b. [**Encore Wire Corporation**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.

1) Submersible Pump Cable: Also investigated in accordance with UL CCN FDNP, including NSF 61.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Material: Type THW.
d. Insulation Temperature Rating: 75 deg C.
e. Conductor Material: Copper.
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.

2.3 THERMOSET-INSULATED WIRE

A. Description: Thermoset-insulated wire for use in accordance with Article 310 of NFPA 70.

B. UL ZKST - Type RHH Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
    b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    g. Marked "VW-1," indicating compliance with special vertical flame test.
    h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
    i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance

with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

C. UL ZKST - Type RHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 75 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings**].

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.

d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

D. UL ZKST - Type RHW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 90 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

E. UL ZKST - Type SA Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Okonite Company (The)**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Okonite Company (The)**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Southwire Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: [**90 deg C for dry and damp locations**][**200 deg C for special applications**].
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

F. UL ZKST - Type XHH Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Encore Wire Corporation**]
b. [**Okonite Company (The)**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Encore Wire Corporation**]
b. [**Okonite Company (The)**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 90 deg C.
d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
g. Marked "VW-1," indicating compliance with special vertical flame test.
h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

G. UL ZKST - Type XHHW Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: [**75 deg C for wet locations**][**90 deg C for dry and damp locations**].
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

    a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
    b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
    c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
    d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
    e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
    f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
    g. Marked "VW-1," indicating compliance with special vertical flame test.
    h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
    i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

        1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

H. UL ZKST - Type XHHW-2 Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Okonite Company (The)**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Service Wire Co.**]
    g. [**Southwire Company, LLC**]

h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Cable Tray Use" or "CT," indicating compliance with vertical-tray cable flame test.
   b. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   c. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   d. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   e. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   f. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   g. Marked "VW-1," indicating compliance with special vertical flame test.
   h. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
   i. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

      1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

I. UL ZKST - Type SIS Insulated Switchboard and Switchgear Wire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Cerro Wire LLC**]
   c. [**Encore Wire Corporation**]
   d. [**Okonite Company (The)**]
   e. [**Prysmian Cables and Systems; Prysmian Group North America**]
   f. [**Service Wire Co.**]
   g. [**Southwire Company, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Cerro Wire LLC**]
c. [**Encore Wire Corporation**]
d. [**Okonite Company (The)**]
e. [**Prysmian Cables and Systems; Prysmian Group North America**]
f. [**Service Wire Co.**]
g. [**Southwire Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

4. Standard Features:

   a. Referenced Standard: Article 310 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating: 90 deg C.
   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

   a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
   b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
   c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
   d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
   e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
   f. Marked "VW-1," indicating compliance with special vertical flame test.
   g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
   h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

      1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

J. UL ZKST - Thermoset-Insulated Submersible Pump Multiconductor Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Prysmian Cables and Systems; Prysmian Group North America**]
   c. [**Service Wire Co.**]
   d. [**Southwire Company, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Service Wire Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

1) Submersible Pump Cable: Also investigated in accordance with UL CCN FDNP, including NSF 61.

4. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Material: Type RHW-2.
d. Insulation Temperature Rating: 90 deg C.
e. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
f. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.
b. Marked "Oil Resistant I" or "PR I," indicating 60 deg C oil resistance.
c. Marked "Oil Resistant II" or "PR II," indicating 75 deg C oil resistance.
d. Marked "Gasoline and Oil Resistant I" or "GR I," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 60 deg C.
e. Marked "Gasoline and Oil Resistant II" or "GR II," indicating suitable for exposure to gasoline at 23 deg C and exposure to mineral oil at 75 deg C.
f. Marked "VW-1," indicating compliance with special vertical flame test.
g. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
h. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

2.4 NONMETALLIC UNDERGROUND CONDUIT WITH CONDUCTORS

A. Nonmetallic Underground Conduit with Conductors, Type NUCC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**Paige Electric Co, LP**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**Paige Electric Co, LP**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Description: A factory assembly of conductors or cables inside a nonmetallic, smooth-wall raceway with a circular cross section.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Type NUCC Conduit with Conductors: UL CCN QQRK, including UL 1990.

5. Standard Features:

a. Referenced Standard: Article 354 of NFPA 70.
b. Conduit Material: [**HDPE-40**][**HDPE-80**][**EPEC-B**].
c. Conduit Sizes: As indicated on the Drawings.
d. Preinstalled Conductors: Provide insulated conductors as indicated on the Drawings.

2.5 METALLIC SHEATHED CABLE

A. UL PJAZ - Metal-Clad Cable, Type MC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Cerro Wire LLC**]
e. [**Copperweld**]
f. [**Encore Wire Corporation**]
g. [**General Cable; Prysmian Group North America**]
h. [**Okonite Company (The)**]
i. [**Southwire Company, LLC**]
j. [**WESCO**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Cerro Wire LLC**]
e. [**Copperweld**]
f. [**Encore Wire Corporation**]
g. [**General Cable; Prysmian Group North America**]
h. [**Okonite Company (The)**]
i. [**Southwire Company, LLC**]
j. [**WESCO**]
k. <**Insert manufacturer's name**>

3. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Metal-Clad Cable: UL CCN PJAZ, including UL 1569.

5. Standard Features:

   a. Referenced Standard: Article 330 of NFPA 70.
   b. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
   c. Conductors: [**Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors**][**Aluminum, complying with ASTM B800 and ASTM B801**].
   d. Ground Conductor: [**Bare**][**Insulated**][**None**].
   e. Conductor Insulation:

      1) Type TFN/THHN/THWN-2. Comply with UL 83.
      2) Type XHHW-2. Comply with UL 44.
      3) <**Insert type and standard**>.

   f. Armor: [**Steel**][**Aluminum**], interlocked.
   g. Jacket: PVC applied over armor.

6. Other Available Features Required by the Project:

   a. Marked "MC-HL," indicating compliance with UL 2225 for use in hazardous (classified) locations.

B. UL AWEZ - Armored Cable, Type AC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Alpha Wire; brand of Belden, Inc.**]
   c. [**Belden Inc.**]
   d. [**Encore Wire Corporation**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Okonite Company (The)**]

g. [**Southwire Company, LLC**]
h. [**WESCO**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AFC Cable Systems; Atkore International**]
b. [**Alpha Wire; brand of Belden, Inc.**]
c. [**Belden Inc.**]
d. [**Encore Wire Corporation**]
e. [**General Cable; Prysmian Group North America**]
f. [**Okonite Company (The)**]
g. [**Southwire Company, LLC**]
h. [**WESCO**]
i. <**Insert manufacturer's name**>

3. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Armored Cable: UL CCN AWEZ, including UL 4.

5. Standard Features:

a. Referenced Standard: Article 320 of NFPA 70.
b. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
c. Conductors: [**Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors**][**Aluminum, complying with ASTM B800 and ASTM B801**].
d. Ground Conductor: [**Bare**][**Insulated**][**None**].
e. Armor: [**Steel**][**Aluminum**], interlocked.

6. Other Available Features Required by the Project:

a. Marked "LS" or "For Use in Cable Trays," indicating compliance with UL 1685 flame and limited smoke test.

C. UL PPKV and FHJR - Fire-Resistant Mineral-Insulated Metal-Sheathed Cable, Type MI, for Use in Electrical Circuit Integrity Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**PYROTENAX; brand of nVent Electrical plc**]
b. [**TEC International**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**PYROTENAX; brand of nVent Electrical plc**]
b. [**TEC International**]
c. <**Insert manufacturer's name**>

3. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Mineral-Insulated Metal-Sheathed Cable: UL CCN PPKV, including UL Subject 504.
b. Circuit Integrity: UL CCN FHJR, including UL 2196.

5. Standard Features:

a. Referenced Standard: Article 332 of NFPA 70.
b. Fire-Resistance Rating: [**1 h**][**2 h**].
c. Conductors: Copper, complying with ASTM B3 for bare annealed copper.
d. Insulation: [**Compressed magnesium oxide**]<**Insert material**>.
e. Sheath: [**Copper**]<**Insert material**>.

D. UL PJAZ and FHJR - Fire-Resistant Metal-Clad Cable, Type MC, for Use in Electrical Circuit Integrity Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. <**Insert manufacturer's name**>

3. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Metal-Clad Cable: UL CCN PJAZ, including UL 1569.
b. Circuit Integrity: UL CCN FHJR, including UL 2196.

5. Standard Features:

a. Referenced Standard: Article 330 of NFPA 70.

b. Fire-Resistance Rating: [**1 h**][**2 h**].
c. Circuits: [**Single circuit**][**and**][**multicircuit with color-coded conductors**].
d. Conductors: [**Copper**][**Copper-clad aluminum**].
e. Ground Conductor: [**Bare**][**Insulated**][**None**].
f. Armor: [**Steel**][**Aluminum**], interlocked.
g. Jacket: PVC applied over armor.

6. Other Available Features Required by the Project:

a. Marked "MC-HL," indicating compliance with UL 2225 for use in hazardous (classified) locations.

2.6 PHOTOVOLTAIC SINGLE-CONDUCTOR CABLE

A. Photovoltaic Single-Conductor Cable, Type PV :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Copperweld**]
b. [**Encore Wire Corporation**]
c. [**General Cable; Prysmian Group North America**]
d. [**Service Wire Co.**]
e. [**Southwire Company, LLC**]
f. [**WESCO**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Copperweld**]
b. [**Encore Wire Corporation**]
c. [**General Cable; Prysmian Group North America**]
d. [**Service Wire Co.**]
e. [**Southwire Company, LLC**]
f. [**WESCO**]
g. <**Insert manufacturer's name**>

3. Description: Flexible, insulated and uninsulated, drawn-copper current-carrying conductor with an overall insulation layer or jacket, or both, rated [**2000**][**600**] V.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Photovoltaic Wire: UL CCN ZKLA, including UL 4703.

5. Standard Features:

a. Referenced Standard: Article 609 of NFPA 70.
b. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

2.7 NONMETALLIC JACKETED CABLE

A. UL PWVX - Nonmetallic-Sheathed Cable, Type NM-B and Type NMC-B :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Copperweld**]
    d. [**Encore Wire Corporation**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Republic Wire Inc.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Copperweld**]
    d. [**Encore Wire Corporation**]
    e. [**Prysmian Cables and Systems; Prysmian Group North America**]
    f. [**Republic Wire Inc.**]
    g. [**Southwire Company, LLC**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Type NM-B and Type NMC-B Cables: UL CCN PWVX, including UL 719.

4. Standard Features:

    a. Referenced Standard: Article 334 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: Individual conductors are rated 90 deg C for multiple conductor ampacity calculations; however, final cable ampacity rating must not exceed value for 60 deg C in Table 310.15(C)(1) of NFPA 70.
    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

        1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

    f. Cable Covering:

        1) Type NM-B: Flame retardant and moisture resistant.
        2) Type NMC-B: Flame retardant, moisture resistant, fungus resistant, and corrosion resistant.

B. UL YDUX - Underground Feeder and Branch-Circuit Cable, Type UF and Type UF-B :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Copperweld**]
   e. [**Encore Wire Corporation**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Republic Wire Inc.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AFC Cable Systems; Atkore International**]
   b. [**Belden Inc.**]
   c. [**Cerro Wire LLC**]
   d. [**Copperweld**]
   e. [**Encore Wire Corporation**]
   f. [**Prysmian Cables and Systems; Prysmian Group North America**]
   g. [**Republic Wire Inc.**]
   h. [**Southwire Company, LLC**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type UF and Type UF-B Cables: UL CCN YDUX, including UL 493.

4. Standard Features:

   a. Referenced Standard: Article 340 of NFPA 70.
   b. Insulation Voltage Rating: 600 V.
   c. Insulation Temperature Rating:

      1) Type UF: 60 deg C.
      2) Type UF-B: Individual conductors are rated 90 deg C for multiple conductor ampacity calculations; however, final cable ampacity rating must not exceed value for 60 deg C in Table 310.15(C)(1) of NFPA 70.

   d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
   e. Conductor Size:[**As indicated on the Drawings.**]

      1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

   f. Cable Covering: Flame retardant, moisture resistant, fungus resistant, corrosion resistant, and suitable for direct burial in the earth.

C. UL TYLZ - Service-Entrance Cable, Type SE, Type USE, and Type USE-2 :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Republic Wire Inc.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Cerro Wire LLC**]
    c. [**Encore Wire Corporation**]
    d. [**Marmon Industrial Energy & Infrastructure; division of Marmon Electrical; a Berkshire Hathaway company**]
    e. [**Okonite Company (The)**]
    f. [**Prysmian Cables and Systems; Prysmian Group North America**]
    g. [**Republic Wire Inc.**]
    h. [**Southwire Company, LLC**]
    i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Service-Entrance Cable: UL CCN TYLZ, including UL 854.

4. Standard Features:

    a. Referenced Standard: Article 338 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: Not in excess of rating for insulation type specified below:

        1) Type THWN: 75 deg C, dry and wet locations.
        2) Type THWN-2: 90 deg C, dry and wet locations.
        3) Type RHW: 75 deg C, dry and wet locations.
        4) Type XHHW: 90 deg C, dry and damp locations; 75 deg C, wet locations.
        5) Type RHW-2: 90 deg C, dry and wet locations.
        6) Type XHHW-2: 90 deg C, dry and wet locations.

    d. Conductor Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
    e. Conductor Size:[**As indicated on the Drawings.**]

1) Minimum Conductor Size: [**14 AWG**][**12 AWG**][**10 AWG**].

5. Other Available Features Required by the Project:

a. Marked "Style R," indicating that cable assembly includes uninsulated equipment ground conductor with insulated conductors.
b. Marked "Style U," indicating that cable assembly includes uninsulated equipment ground conductor helically wrapped over insulated conductors.
c. Marked "-HF," indicating that combustible materials are halogen-free when tested in accordance with UL Subject 2885.

1) Marked "-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

D. UL QPOR - Power and Control Tray Cable, Type TC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Encore Wire Corporation**]
d. [**General Cable; Prysmian Group North America**]
e. [**Okonite Company (The)**]
f. [**Southwire Company, LLC**]
g. [**WESCO**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alpha Wire; brand of Belden, Inc.**]
b. [**Belden Inc.**]
c. [**Encore Wire Corporation**]
d. [**General Cable; Prysmian Group North America**]
e. [**Okonite Company (The)**]
f. [**Southwire Company, LLC**]
g. [**WESCO**]
h. <**Insert manufacturer's name**>

3. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Power and Control Tray Cable: UL CCN QPOR, including UL 1277.

5. Standard Features:

a. Comply with NEMA WC 57/ICEA S-73-532 for Type TC cables used for control, thermocouple extension, and instrumentation.
b. Comply with NEMA WC 70/ICEA S-95-658 for Type TC cables used for power distribution.

c. Conductors: [**Copper**][**Aluminum**][**Copper-clad aluminum**].
d. Ground Conductor: [**Bare**][**Insulated**][**None**].
e. Conductor Insulation: Type XHHW-2. Comply with UL 44.

6. Other Available Features Required by the Project:

a. Marked "TC-ER," indicating that cable is designed for use with ASDs, with oversized crosslinked polyethylene insulation, [**spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire**][**dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires**], and sunlight- and oil-resistant outer PVC jacket.

1) Marked "TC-ER-JP," indicating that cable is also suitable for pulling through structural members in accordance with Article 336.10(9) of NFPA 70.
2) Marked "TC-ER-HL," indicating that cable is also suitable for use in hazardous (classified) environments.

b. Marked "ST1," indicating compliance with UL 1685 flame and smoke test.
c. Marked "ST1-HF," indicating that combustible materials are halogen-free in accordance with UL Subject 2885.

1) Marked "ST1-LSHF," indicating that combustible materials are low smoke when also tested in accordance with IEC 61034-2.

2.8 CONNECTORS AND SPLICES

A. UL PJOX - Armored and Metal-Clad Cable Fittings :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Installation Products**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**American Fittings Corp. (AMFICO)**]
d. [**Arlington Industries, Inc.**]
e. [**Bridgeport Fittings Inc.**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Halex; division of Scott Fetzer Co.**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**O-Z/Gedney; brand of Appleton Group**]
j. [**Service Wire Co.**]
k. [**SIGMA Engineered Solutions**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Installation Products**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**American Fittings Corp. (AMFICO)**]
d. [**Arlington Industries, Inc.**]

e. [**Bridgeport Fittings Inc.**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Halex; division of Scott Fetzer Co.**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**O-Z/Gedney; brand of Appleton Group**]
j. [**Service Wire Co.**]
k. [**SIGMA Engineered Solutions**]
l. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type AC and Type MC Cable Connectors: UL CCN PJOX, including UL 514B.

4. Standard Features: For steel and aluminum sheathed cables, designed to connect conductors specified in this Section.

B. UL PPYT - Mineral-Insulated Metallic-Sheathed Cable Fittings :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**TEC International**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**TEC International**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Type MI Cable Fittings: UL CCN PPYT, including UL 514B.

4. Standard Features: For copper sheathed cables, designed to connect conductors specified in this Section.

C. UL ZMVV - Wire Connectors and Soldering Lugs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Installation Products**]
   b. [**Amphenol TPC Wire & Cable**]
   c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Eaton**]
   e. [**Fastenal Co.**]

f. [**Gardner Bender; brand of ECM Industries LLC; division of nVent Electric plc**]
g. [**Hillsdale Terminal**]
h. [**Ideal Industries, Inc.**]
i. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
j. [**Marinco Power Products**]
k. [**Morris Products Inc.**]
l. [**Newark; an Avnet Company**]
m. [**Panduit Corp**]
n. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
o. [**TE Connectivity Ltd.**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Installation Products**]
b. [**Amphenol TPC Wire & Cable**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Eaton**]
e. [**Fastenal Co.**]
f. [**Gardner Bender; brand of ECM Industries LLC; division of nVent Electric plc**]
g. [**Hillsdale Terminal**]
h. [**Ideal Industries, Inc.**]
i. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
j. [**Marinco Power Products**]
k. [**Morris Products Inc.**]
l. [**Newark; an Avnet Company**]
m. [**Panduit Corp**]
n. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
o. [**TE Connectivity Ltd.**]
p. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Wire Connectors and Soldering Lugs: UL CCN ZMVV, including UL 486A-486B or UL 486C.

4. Standard Features:

a. One piece, seamless, designed to terminate conductors specified in this Section.
b. Material: [**Copper**][**Aluminum**][**Bronze**].
c. Type: [**One**][**Two**] hole with [**standard**][**long**] barrels.
d. Termination: [**Compression**][**Crimp**].

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper, aluminum, or copper-clad aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Material: [**Copper**][**Aluminum**][**Copper-clad aluminum**].

a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
b. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. PV Circuits: [**Copper**][**Aluminum**][**Copper-clad aluminum**]; Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Type USE, single conductor in raceway**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Multiconductor cable, Type SE**].

B. Exposed Feeders: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Underground feeder cable, Type UF**].

E. Feeders Installed below Raised Flooring: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**].

F. Feeders in Cable Tray: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors larger than No. 1/0 AWG**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

G. Exposed Branch Circuits, Including in Crawlspaces: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors in raceway**][**Underground branch-circuit cable, Type UF**].

J. Branch Circuits Installed below Raised Flooring: [**Type THHN/THWN-2, single conductors in raceway**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**].

K. Branch Circuits in Cable Tray: [**Type THHN/THWN-2, single conductors in raceway**][**Type XHHW-2, single conductors larger than No. 1/0 AWG**][**Armored cable, Type AC**][**Metal-clad cable, Type MC**][**Mineral-insulated, metal-sheathed cable, Type MI**][**Nonmetallic-sheathed cable, Type NM**].

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

M. ASD Output Circuits: [**Type XHHW-2 in metal conduit**][**Type TC-ER cable with braided shield**][**Type TC-ER cable with dual tape shield**].

N. PV Circuits, Type USE-2: For PV source circuits rated at 600 V or less.

O. PV Circuits, Type PV: For PV source circuits rated at [**600**][**1000**][**2000**] V.

3.3 INSTALLATION OF LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installation of Type AC and Type MC Cables: NECA NEIS 120.
9. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
2. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
6. Provide support for cables.
7. Complete cable tray systems installation prior to installing conductors and cables.
8. Connections:

    a. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

b. Make splices, terminations, and taps that are compatible with conductor material[**and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors**].

1) Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

9. Wiring at Outlets: Install conductor at each outlet, with at least [**6 inch (150 mm)**][**12 inch (300 mm)**] of slack.

D. Interfaces with Other Work:

1. Identification:

a. Identify and color-code conductors and cables.
b. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

2. Sleeves and Sleeve Seals: Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
3. Firestopping: Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
3. After installing conductors and cables and before electrical circuitry has been energized, test [**service entrance and feeder conductors**][**and**][**conductors**] feeding the following critical equipment and services for compliance with requirements:

a. <**Insert, in separate subparagraphs, critical equipment and services to be tested**>.

4. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection in accordance with the single-line diagram.
b. Test bolted connections for high resistance using one or more of the following:

1) A low-resistance ohmmeter.
2) Calibrated torque wrench.
3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.
f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.
h. Uniform resistance of parallel conductors.

E. Nonconforming Work:

1. Wire or cable assembly will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 MAINTENANCE

A. Infrared Scanning of Splices: Two months after Substantial Completion, perform infrared scan of splices, joints, and connections in conductors 3 AWG and larger. Remove covers so splices, joints, and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison. Correct deficiencies determined during the scan.

1. Follow-On Infrared Scanning: Perform follow-up infrared scan of splices at 11 months after Substantial Completion.
2. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies cables splices checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 05 19 00

Task	Specification	Specification Description
26 05 19 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 19 13	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 19 13	26 05 39 00	Underfloor Raceways For Electrical Systems
26 05 19 13	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 19 16	26 05 13 00	Medium-Voltage Cables
26 05 19 16	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 19 16	26 05 23 00	Control-Voltage Electrical Power Cables
26 05 19 16	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 19 16	27 11 00 00	Communications Equipment Room Fittings
26 05 19 16	27 13 13 00	Communications Copper Backbone Cabling
26 05 19 16	27 15 33 00	Communications Coaxial Horizontal Cabling

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SECTION 26 05 23 00 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cable hardware.
6. Twin-axial data highway cable.
7. RS-232 cable.
8. RS-485 cable.
9. Control cable.
10. Control-circuit conductors.
11. Fire-alarm wire and cable.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cable hardware.
6. Twin-axial data highway cable.
7. RS-232 cable.
8. RS-485 cable.
9. Control cable.
10. Control-circuit conductors.
11. Fire-alarm wire and cable.

B. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.

7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: **60 inch (1520 mm)** or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 BACKBOARDS

A. Description: Plywood, [**fire-retardant treated,**]**3/4 by 48 by 96 inch (19 by 1220 by 2440 mm)**. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with [**flat**][**eggshell**][**black**]<**Insert color**>[**latex**][**alkyd**] paint. Comply with requirements in Section 099123 "Interior Painting."

1. Lead Content: Less than 300 parts per million.

2.3 CATEGORY 5e BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

E. Conductors: 100 ohm, No. 24 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

2.4 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]

11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

D. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

E. Conductors: 100 ohm, No. 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.5 CATEGORY 6a BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. **<Insert manufacturer's name>**

D. Standard: Comply with TIA-568-C.2 for Category 6a cables.

E. Conductors: 100 ohm, No. 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.6 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]

18. **<Insert manufacturer's name>**

C. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]
18. **<Insert manufacturer's name>**

D. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of [**Category 5e**][**Category 6**][**Category 6a**][**Category 7**].
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables must be terminated with connecting hardware of same category or higher.

E. Source Limitations: [**Obtain balanced twisted pair cable hardware from single source from single manufacturer**][**Obtain balanced twisted pair cable hardware from same manufacturer as balanced twisted pair cable, from single source**].

F. Connecting Blocks: [**110-style IDC for Category 5e**][**110-style IDC for Category 6**][**66-style IDC for Category 5e**]. Provide blocks for the number of cables terminated on the block, plus [**25**]**<Insert number>** percent spare, integral with connector bodies, including plugs and jacks where indicated.

G. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: [**One**]**<Insert number>** for each conductor in assigned cables.

H. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on **19 inch (483 mm)** equipment racks.

3. Number of Jacks per Field: One for each four-pair [**cable indicated**][**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].

I. Patch Cords: Factory-made, four-pair cables in [**36 inch (900 mm)**][**48 inch (1200 mm)**]<**Insert length**>lengths; terminated with an eight-position modular plug at each end.

1. Patch cords must have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords must have latch guards to protect against snagging.
2. Patch cords must have color-coded boots for circuit identification.

J. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

K. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:

    a. Category 5e, unshielded balanced twisted pair cable must comply with IEC 60603-7-2.
    b. Category 5e, shielded balanced twisted pair cable must comply with IEC 60603-7-3.
    c. Category 6, unshielded balanced twisted pair cable must comply with IEC 60603-7-4.
    d. Category 6, shielded balanced twisted pair cable must comply with IEC 60603-7.5.
    e. Category 6a, unshielded balanced twisted pair cable must comply with IEC 60603-7-41.
    f. Category 6a, shielded balanced twisted pair cable must comply with IEC 60603-7.51.

4. Marked to indicate transmission performance.

L. Faceplate:

1. [**Two**][**Four**][**Six**] port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. [**Eight**][**10**][**12**] port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
4. Metal Faceplate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

M. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 TWIN-AXIAL DATA HIGHWAY CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, <**Insert number**> pairs, [**No. 20**][**No. 22**][**No. 24**] AWG, stranded [**(7x28)**][**(7x30)**][**(7x32)**] tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1685.
7. Lead Content: Less than 300 parts per million.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, <**Insert number**> pairs, [**No. 20**][**No. 22**][**No. 24**] AWG, stranded [**(7x28)**][**(7x30)**][**(7x32)**] tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.
7. Lead Content: Less than 300 parts per million.

2.8 RS-232 CABLE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Wire & Cable Inc.**]
2. [**Belden Inc.**]
3. [**General Cable; Prysmian Group North America**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Wire & Cable Inc.**]
2. [**Belden Inc.**]
3. [**General Cable; Prysmian Group North America**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. PVC-Jacketed, TIA 232-F:

1. [**Three**][**Nine**], No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Lead Content: Less than 300 parts per million.
3. Polypropylene insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. PVC jacket.

6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. NFPA 70 Type: Type CM.
8. Flame Resistance: Comply with UL 1581.

D. Plenum-Type, TIA 232-F:

1. [**Three**][**Nine**], No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Lead Content: Less than 300 parts per million.
3. PE insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. Fluorinated ethylene propylene jacket.
6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. Flame Resistance: Comply with NFPA 262.

2.9 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, [**one pair**][**two pairs**], twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, [**one pair**][**two pairs**], No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.
6. Lead Content: Less than 300 parts per million.

2.10 CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. [**One**][**Multi-**]pair, twisted, [**No. 16 AWG, stranded (19x29)**][**No. 18 AWG, stranded (19x30)**] tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. [**One**][**Multi-**]pair, twisted, [**No. 16 AWG, stranded (19x29)**][**No. 18 AWG, stranded (19x30)**] tinned-copper conductors.
2. PVC insulation.
3. Unshielded.

4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.
6. Lead Content: Less than 300 parts per million.

2.11 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Encore Wire Corporation**]
2. [**General Cable; Prysmian Group North America**]
3. [**Service Wire Co.**]
4. [**Southwire Company, LLC**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [**Encore Wire Corporation**]
2. [**General Cable; Prysmian Group North America**]
3. [**Service Wire Co.**]
4. [**Southwire Company, LLC**]
5. <**Insert manufacturer's name**>

C. Class 1 Control Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type THW, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**Type TC, complying with UL 1277 in raceway**][**Type MC, complying with UL 1569**].

D. Class 2 Control Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**power-limited cable, concealed in building finishes**][**power-limited tray cable, in cable tray**].

E. Class 3 Remote-Control and Signal Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**][**Type XHHW-2, complying with UL 44 in raceway**][**power-limited cable, concealed in building finishes**][**power-limited tray cable, in cable tray**][**Type TW or Type TF, complying with UL 83, in raceway**].

F. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.
2. <**Insert list of critical circuits that require CI cable**>.

2.12 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Allied Wire & Cable Inc.**]
2. [**CommScope, Inc**]
3. [**Comtran Corporation**]

4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Radix Wire**]
7. [**Rockbestos-Suprenant Cable Corp.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. [**West Penn Wire; brand of Belden, Inc.**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Allied Wire & Cable Inc.**]
2. [**CommScope, Inc**]
3. [**Comtran Corporation**]
4. [**Genesis; Resideo Technologies, Inc.**]
5. [**Prysmian Cables and Systems; Prysmian Group North America**]
6. [**Radix Wire**]
7. [**Rockbestos-Suprenant Cable Corp.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. [**West Penn Wire; brand of Belden, Inc.**]
10. <**Insert manufacturer's name**>

C. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

1. Lead Content: Less than 300 parts per million.

D. Signaling Line Circuits: Twisted, shielded pair, [**not less than**][**No. 18 AWG**]<**Insert wire size**>[**size as recommended by system manufacturer**].

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

E. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor[**with outer jacket**] with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or modified in this Section.

B. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems" for raceway selection and installation requirements for wireways as supplemented or modified in this Section.

C. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for raceway selection and installation requirements for boxes as supplemented or modified in this Section.

1. Outlet boxes must be no smaller than **2 inch (50 mm)** wide, **3 inch (75 mm)** high, and **2-1/2 inch (64 mm)** deep.
2. Outlet boxes for cables must be no smaller than **4 inch (102 mm)** square by [**1-1/2 inch (38 mm)**][**2-1/8 inch (53 mm)**] deep with extension ring sized to bring edge of ring to within **1/8 inch (3.1 mm)** of the finished wall surface.
3. Flexible metal conduit must not be used.

D. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows if possible.

F. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits [**3 inch (75 mm)**]<**Insert dimension**> above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with **96 inch (2440 mm)** dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than **1/2 inch (12 mm)** at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of **8 inch (200 mm)** above ceilings by cable supports not more than [**30 inch (760 mm)**]<**Insert dimension**> apart.
3. Cable must not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of [72 inch (1830 mm)]<**Insert dimension**> of cable in a coil not less than [12 inch (305 mm)]<**Insert dimension**> in diameter.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **5 inch (127 mm)**.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **12 inch (305 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **24 inch (600 mm)**.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **2-1/2 inch (64 mm)**.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **6 inch (150 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **12 inch (305 mm)**.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures must be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **3 inch (75 mm)**.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **6 inch (150 mm)**.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of **48 inch (1200 mm)**.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inch (127 mm)**.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; [**No 14 AWG**]<**Insert wire size**>.
2. Class 2 low-energy, remote-control, and signal circuits; [**No. 16 AWG**]<**Insert wire size**>.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; [**No 12 AWG**]<**Insert wire size**>.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers must use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 05 23 00

Task	Specification	Specification Description
26 05 23 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 26 00 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connectors.
7. Grounding and bonding busbars.
8. Signal reference grids.
9. Grounding (earthing) electrodes.
10. Grounding electrode enclosures.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 264113 "Lightning Protection for Structures" specifies bonding of lightning protection grounding electrodes to facility grounding electrodes.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
6. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for identification and grounding and bonding of communications equipment, raceways, boxes, and cable trays.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for

submitted product.

B. Shop Drawings: Prepare and submit the following:

1. Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:

a. Grounding electrode access enclosures.
b. Grounding electrodes.
c. Grounding arrangements and connections for separately derived systems.
d. <**Insert items**>.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

D. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:

a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:

1) Grounding electrode access enclosures.
2) Grounding electrodes.
3) Grounding arrangements and connections for separately derived systems.
4) <**Insert items**>.

b. Instructions for periodic testing and inspection of grounding features at [**test wells**][**ring electrodes**][**grounding connections for separately derived systems**]<**Insert locations**> based on [**NETA MTS**][**NFPA 70B**]<**Insert reference**>.

1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
2) Include recommended testing intervals.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical

tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems, evaluate tests, test equipment, test results, and power system performance, recommend actions to maintain or improve system performance, and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.6 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Soil Resistivity: Grounding (earthing) Work on the Project must account for soil resistivity conditions specified in Section 018116 "Facility Environmental Requirements."

B. Electrical and ICT Equipment Grounding (Earthing): Do not exceed [**25 Ω**][**10 Ω**]<**Insert resistance value**> resistance to ground (earth).

1. Contact Architect for resolution if 25 Ω specified resistance to ground (earth) is not attained after complying with prescriptive requirements in Article 250 of NFPA 70.
2. Contact Architect for resolution if [**10 Ω**]<**Insert resistance value**> specified resistance to ground (earth) is not attained after second attempt to increase effectiveness of grounding (earthing) electrode.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <**Insert additional performance requirements for the Project**>.

2.2 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. Standard Features: 600 V, [**THHN/THWN-2**][**or**][**THWN-2**], [**copper**][**or**][**tinned-copper**] wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. Standard Features: 600 V, [**THHN/THWN-2**][**or**][**THWN-2**], [**copper**][**or**][**tinned-copper**] wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ERICO; brand of nVent Electrical plc**]
   b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ERICO; brand of nVent Electrical plc**]
   b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   c. <**Insert manufacturer's name**>

3. Standard Features: Complying with one or more of the following:

   a. Soft or Annealed Copper Wire: ASTM B3.
   b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
   c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
   d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

4. Sustainable Design Features:

   a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER - Armored Grounding Wire:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**LS Cable & System USA; subsidiary of LS Corp.**]
   b. [**Southwire Company, LLC**]
   c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   d. [**Viakon; brand of Conductores Monterrey S.A. de C.V.; a subsidiary of Xignux**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**LS Cable & System USA; subsidiary of LS Corp.**]
    b. [**Southwire Company, LLC**]
    c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    d. [**Viakon; brand of Conductores Monterrey S.A. de C.V.; a subsidiary of Xignux**]
    e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

4. Standard Features: Single corrosion-resistant copper, aluminum, or copper-clad aluminum conductor within helically formed steel armor.
5. Sustainable Design Features:

    a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
    b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDSH - Protector Grounding Conductor:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features:

a. Conductors intended to be used for grounding primary protector or metallic members of cable sheath in accordance with Chapters 7 and 8 of NFPA 70.
b. Color: [**Light olive gray**][**or**][**green**].

5. Sustainable Design Features:

a. Lead Content for Electrical Wire and Cable: Less than 300 ppm.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.3 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.

B. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
    c. [**Arlington Industries, Inc.**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    f. [**ERICO; brand of nVent Electrical plc**]
    g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
    h. [**Greaves Corp.; Essex Products Group, Inc.**]
    i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
    k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    l. [**Panduit Corp**]
    m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

    a. Two pieces with [**zinc-plated**][**stainless steel**] bolts.
    b. Clamp Material: [**Silicon bronze**][**Die-cast zinc alloy**][**Aluminum**][**Brass**][**Tinned brass**].
    c. Listed for outdoor use.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**America Fujikura Ltd. (AFL); Fujikura Ltd.**]
c. [**Arlington Industries, Inc.**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**ERICO; brand of nVent Electrical plc**]
g. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
h. [**Greaves Corp.; Essex Products Group, Inc.**]
i. [**Harger Lightning & Grounding; business of Harger, Inc.**]
j. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
k. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
l. [**Panduit Corp**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

a. Clamp Material: [**Aluminum**][**Brass**][**Tinned brass**].
b. Listed for outdoor use.

6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**ERICO; brand of nVent Electrical plc**]
   d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   e. [**Panduit Corp**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**ERICO; brand of nVent Electrical plc**]
   d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   e. [**Panduit Corp**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features:

   a. Clamp Material: [**Aluminum**][**Copper**][**Tinned copper**][**Galvanized steel**].
   b. Listed for outdoor use.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced

(extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDER - Beam Grounding and Bonding Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anderson; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Panduit Corp**]
   d. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Anderson; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Panduit Corp**]
   d. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL KDER - Exothermically Welded Connection :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**ALLTEC LLC**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**ALLTEC LLC**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**ERICO; brand of nVent Electrical plc**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL KDER - Raised-Floor Signal Reference Grid Clamp :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**ERICO; brand of nVent Electrical plc**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**ERICO; brand of nVent Electrical plc**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, stamped-steel terminal with hex head screw.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.4 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. UL KDER - Bonding Bushing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Arlington Industries, Inc.**]
    c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Arlington Industries, Inc.**]
    c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Threaded bushing with insulated throat.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Grounding Bushing :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Arlington Industries, Inc.**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Threaded bushing with insulated throat and mechanical-type wire terminal.
6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 GROUNDING AND BONDING HUBS

A. UL KDER - Grounding and Bonding Hub :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Arlington Industries, Inc.**]
    c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Greaves Corp.; Essex Products Group, Inc.**]
    f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    g. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Arlington Industries, Inc.**]
    c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Greaves Corp.; Essex Products Group, Inc.**]
    f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    g. [**Penn-Union Corp.; subsidiary of Nesco, Inc.**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Insulated, gasketed, watertight hub with mechanical-type wire terminal.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.6 GROUNDING AND BONDING CONNECTORS

A. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Chatsworth Products, Inc.**]
c. [**Greaves Corp.; Essex Products Group, Inc.**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Chatsworth Products, Inc.**]
c. [**Greaves Corp.; Essex Products Group, Inc.**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Mechanical-type, [**aluminum**][**copper rated for direct burial**] terminal with set screw.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
c. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
c. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on **5/8 or 1 inch (16 or 25 mm)** centers for two-bolt connection to busbar.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Panduit Corp**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Panduit Corp**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**aIIG Fabrication (formerly ALT)**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**aIIG Fabrication (formerly ALT)**]
c. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.

    a. [**Copper**][**Copper alloy**][**Tinned copper**], C and H shaped.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**allG Fabrication (formerly ALT)**]
    c. [**ERICO; brand of nVent Electrical plc**]
    d. [**Greaves Corp.; Essex Products Group, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**allG Fabrication (formerly ALT)**]
    c. [**ERICO; brand of nVent Electrical plc**]
    d. [**Greaves Corp.; Essex Products Group, Inc.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened.

a. [**Copper**][**Copper alloy**][**Tinned copper**].

6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL KDER - Signal Reference Grid Grounding and Bonding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**ERICO; brand of nVent Electrical plc**]
e. [**Harger Lightning & Grounding; business of Harger, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**ERICO; brand of nVent Electrical plc**]
e. [**Harger Lightning & Grounding; business of Harger, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Standard Features: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.7 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.

B. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   b. [**Madison Electric Products; business of Southwire Company, LLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   b. [**Madison Electric Products; business of Southwire Company, LLC**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features: Zinc-alloy one-piece construction; six terminating points; gangable.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced

(extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Standard Features: [**Zinc-alloy**][**Copper**] body and polycarbonate cover; four terminating points.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.8 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.

B. UL KDER - Equipment Room Grounding and Bonding Busbar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**allG Fabrication (formerly ALT)**]
    b. [**Chatsworth Products, Inc.**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**ERICO; brand of nVent Electrical plc**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. [**Hoffman; brand of nVent Electrical plc**]
    h. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
    i. [**Panduit Corp**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**allG Fabrication (formerly ALT)**]
    b. [**Chatsworth Products, Inc.**]
    c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    e. [**ERICO; brand of nVent Electrical plc**]
    f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    g. [**Hoffman; brand of nVent Electrical plc**]
    h. [**ILSCO; brand of ECM Industries LLC; division of nVent Electric plc**]
    i. [**Panduit Corp**]
    j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features:

    a. Bus: Rectangular bar of annealed copper.
    b. Mounting Stand-Off Insulators: Lexan or PVC.

        1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability

report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (lgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

7. Other Available Features Required by the Project:

a. Dimensions: [**1/4 by 4 inch (6.3 by 100 mm)**]<**Insert dimensions**> in cross section; length as indicated on the Drawings.

b. Predrilled Hole Pattern: [**Complying with BICSI N3 and TIA-607**][**9/32 inch (7.14 mm) holes spaced 1-1/8 inch (28 mm) apart**][**Suitable for installing specified grounding and bonding connectors**].

c. Mounting Hardware: Stand-off brackets that provide [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**> clearance to access rear of bus. Brackets and bolts must be stainless steel.

C. UL KDER - Rack and Cabinet Bonding Busbar :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Chatsworth Products, Inc.**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
d. [**Hoffman; brand of nVent Electrical plc**]
e. [**Panduit Corp**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Chatsworth Products, Inc.**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
d. [**Hoffman; brand of nVent Electrical plc**]
e. [**Panduit Corp**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features:

   a. Bus: Rectangular bar of hard-drawn solid copper.
   b. Horizontal Mounting Dimensions: Designed for mounting in [**19 inch (483 mm)**][**23 inch (584 mm)**] wide equipment racks or cabinets.
   c. Vertical Mounting Dimensions: Designed for mounting in [**72 inch (1827 mm)**][**36 inch (914 mm)**] high equipment racks or cabinets.
   d. Predrilled Hole Pattern: Accepts connectors for grounding and bonding conductor sizes 14 AWG to 2/0 AWG.
   e. Mounting Hardware: Stainless steel or copper-plated, for attachment to rack.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.9 SIGNAL REFERENCE GRIDS

A. Description: Means for providing low-impedance path to ground over a large area, approximating an equipotential plan, while simultaneously mitigating large current spikes from faults or lightning.

B. UL KDER - Mesh-Type Signal Reference Grid :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Conductive metal wire mesh for field-fabrication of grid.

    a. Wire Size: [**8 AWG**][**6 AWG**][**4 AWG**][**2 AWG**].
    b. Wire Material: [**Copper**][**Copper-clad steel**].
    c. Spacing: [**4 inch (102 mm)**][**8 inch (203 mm)**][**12 inch (305 mm)**][**24 inch (610 mm)**].
    d. Welded or brazed intersections.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL KDER - Tape-Type Signal Reference Grid :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    b. [**ERICO; brand of nVent Electrical plc**]
    c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    b. [**ERICO; brand of nVent Electrical plc**]
    c. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Conductive copper tape for field-fabrication of grid.

   a. Copper Tape Dimensions: [**16 mil (0.4 mm) (26 ga.) thick by 2 inch (51 mm) wide**][**40 mil (1 mm) (18 ga.) thick by 1.6 inch (40 mm) wide**]<**Insert dimensions**>.
   b. Spacing: [**24 inch (610 mm)**]<**Insert dimension**>.
   c. Welded or brazed fittings for intersections.

6. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.10 GROUNDING (EARTHING) ELECTRODES

A. UL KDER - Rod Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**allG Fabrication (formerly ALT)**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**ERICO; brand of nVent Electrical plc**]
   e. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**allG Fabrication (formerly ALT)**]
   c. [**Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
   d. [**ERICO; brand of nVent Electrical plc**]
   e. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
   f. [**Harger Lightning & Grounding; business of Harger, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch by 10 ft (19 mm by 3 m)**][**5/8 inch by 8 ft (16 mm by 2.4 m)**].
6. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL KDER - Chemically Charged Rod Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**aIIG Fabrication (formerly ALT)**]
b. [**ALLTEC LLC**]
c. [**ERICO; brand of nVent Electrical plc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**aIIG Fabrication (formerly ALT)**]
b. [**ALLTEC LLC**]
c. [**ERICO; brand of nVent Electrical plc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: Copper tube, straight or L-shaped, charged electrode enhancement material.

a. Termination: Factory-attached 4/0 AWG bare conductor at least **48 inch (1200 mm)** long.
b. Backfill Material: Electrode manufacturer's recommended material.

6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

7. Other Available Features Required by the Project:

    a. Electrode Enhancement Material: [**Nonhazardous electrolytic chemical salts**]<**Insert enhancement material**>.

C. UL KDER - Plate Electrode :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ALLTEC LLC**]
    b. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ALLTEC LLC**]
    b. [**Galvan Industries, Inc.; Electrical Products Division, LLC**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

5. Standard Features: **1/4 inch (6 mm)** thick, hot-dip galvanized.
6. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.11 GROUNDING ELECTRODE ENCLOSURES

A. Description: Enclosures designed to protect grounding electrodes from damage while providing access for inspection and testing of the grounding system.

B. Grounding Electrode Access Well Enclosure :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ERICO; brand of nVent Electrical plc**]
    b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    c. [**Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ERICO; brand of nVent Electrical plc**]
    b. [**Harger Lightning & Grounding; business of Harger, Inc.**]
    c. [**Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Standard Features:

    a. Well Material: [**Concrete**][**HDPE**][**Schedule 40 PVC**].
    b. Cover Material: [**Cast iron**][**Concrete**][**HDPE**][**Plastic**][**Steel**].
    c. Cover Strength: [**Sidewalk or turf use**][**Driveway use**]<**Insert rating**>.

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Material Reuse: Product is salvaged, refurbished, or reused.
    c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.

f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Round:

1) Nominal Diameter: [**8 inch (200 mm)**][**9 inch (230 mm)**][**10 inch (250 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**]<**Insert dimension**>.
2) Nominal Height: [**10 inch (250 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (760 mm)**][**36 inch (910 mm)**][**48 inch (1220 mm)**]<**Insert dimension**>.
3) Slotted sides for installation after grounding connections made.

b. Rectangular:

1) Nominal Width: [**2 inch (50 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**][**17 inch (430 mm)**][**36 inch (910 mm)**]<**Insert dimension**>.
2) Nominal Length: [**10 inch (250 mm)**][**12 inch (300 mm)**][**13 inch (330 mm)**][**17 inch (430 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**36 inch (910 mm)**][**42 inch (1070 mm)**]<**Insert dimension**>.
3) Nominal Height: [**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (760 mm)**]<**Insert dimension**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

A. Grounding and Bonding Conductors:

1. Provide solid conductor for [**8 AWG**]<**Insert wire size**> and smaller, and stranded conductors for [**6 AWG**]<**Insert wire size**> and larger unless otherwise indicated.
2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, **1/4 inch (6 mm)** in diameter.
4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; **1-5/8 inch (41 mm)** wide and **1/16 inch (1.6 mm)** thick.

6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Underground Grounding Conductors: Install bare [**tinned-**]copper conductor, [**2/0 AWG**]<**Insert wire size**> minimum.

B. Grounding and Bonding Connectors:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.

D. Substation Signal Reference Grid:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with IEEE C2.

a. Install [**8 AWG**][**6 AWG**]<**Insert wire size from fault calculation**> bonding conductors below grade in a grid pattern on 2 ft (600 mm) centers. Bond grid conductors with exothermic welds where they cross each other.
b. Grid must fill entire area inside equipment yard fence, and extend minimum 6.5 ft (2 m) outside fence, so someone walking or running outside yard may not touch fence or open gate without first stepping inside grid.
c. Bond each metal fence post and gate post to at least two grid conductors.
d. Inside grid, bond equipment reinforcing steel inside bases and sidewalks to at least two grid conductors.
e. Bond underground metal pipe and conduit passing under grid to nearest grid conductor at both ends.

E. Signal Reference Grid Tape Mesh:

1. Install tape mesh under floor finish with the following features:

a. Tape mesh, 2 inch (50 mm) by 16 mil (0.4 mm) solid copper, [12 inch (300 mm)][24 inch (610 mm)] spacing.

3.3 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.4 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR TOWERS AND ANTENNAS

A. Special Techniques:

1. Ring Electrode: Buried at least 30 inch (760 mm) below grade and at least 24 inch (610 mm) from base of tower or mounting.
2. Bond each tower base and metallic frame of dish to ring electrode, buried at least 18 inch (460 mm) below grade.
3. Bond ring electrode and antenna bonding conductors to equipment room PBB or SBB, buried at least 30 inch (760 mm) below grade.

4. Bond metal fences located within **6 ft (1.8 m)** of towers and antennas to ring electrode, buried at least **18 inch (460 mm)** below grade.
5. Special Requirements for Roof-Mounted Towers:

    a. Roof Ring: Meet requirements for ring electrode except conductors must comply with NFPA 780.
    b. Bond tower base footings steel, SBB in equipment room, and antenna support guys to roof ring.
    c. Connect roof ring to perimeter conductors of lightning protection system.

6. Special Requirements for Waveguides and Coaxial Cable:

    a. Bond cable shields at point of entry into building to nearest SBB and to cable entrance plate, using 2 AWG bonding conductors.
    b. Bond coaxial cable surge arrester to ring electrode or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.5 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Work in ITE Rooms: NFPA 75.
7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
12. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:

    a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
    b. Underground Grounding Conductors:

        1) Bury at least **30 inch (750 mm)** below grade.
        2) Duct-Bank Grounding Conductor: Bury **12 inch (300 mm)** above duct bank when indicated as part of duct-bank installation.

2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or

electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

    1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
    2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
    3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.

g. Grounding and Bonding for Piping:

    1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
    2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
    3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [**tinned**]bonding jumper to bond across flexible duct connections to achieve continuity.
i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than **60 ft (18 m)** apart.

3. Grounding and Bonding Busbars:

    a. Install busbar horizontally, on insulated spacers **2 inch (50 mm)** minimum from wall, **6 inch (150 mm)** above finished floor unless otherwise indicated.
    b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

4. Electrodes:

    a. Ground Rods: Drive rods until tops are **2 inch (50 mm)** below finished floor or final grade unless otherwise indicated.

        1) Interconnect ground rods with grounding electrode conductor below grade and as

otherwise indicated. Make connections without exposing steel or damaging coating if any.

2) Use exothermic welds for below-grade connections.

b. For grounding electrode system, install at least [**three**]<**Insert number**> rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.

c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least **12 inch (300 mm)** deep, with cover.

1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

d. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each [**steel column**][**indicated item**], extending around perimeter of [**building**][**area or item indicated**].

1) Install tinned-copper conductor not less than [**2/0 AWG**]<**Insert wire size**> for ring electrode and for taps to building steel.

2) Bury ring electrode not less than [**24 inch (600 mm)**]<**Insert dimension**> from building's foundation.

e. Concrete-Encased Electrode (Ufer Ground):

1) Fabricate in accordance with NFPA 70; use minimum of [**20 ft (6 m)**]<**Insert dimension**> of bare copper conductor not smaller than [**4 AWG**]<**Insert wire size**>.

a) If concrete foundation is less than [**20 ft (6 m)**]<**Insert dimension**> long, coil excess conductor within base of foundation.

b) Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

2) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least **20 ft (6.0 m)** long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.

5. Grounding at Service:

a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.

6. Grounding Separately Derived Systems:

a. Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode must be connected to equipment grounding conductor and to frame of generator.

7. Grounding Underground Distribution System Components:

a. Duct-Bank Grounding Conductor: Bury **12 inch (300 mm)** above duct bank when indicated as part of duct-bank installation.

b. Comply with IEEE C2 grounding requirements.
c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so **4 inch (100 mm)** will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from **2 inch (50 mm)** above to **6 inch (150 mm)** below concrete. Seal floor opening with waterproof, nonshrink grout.
d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than **6 inch (150 mm)** from foundation.

8. Equipment Grounding and Bonding:

a. Install insulated equipment grounding conductors with feeders and branch circuits.
b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1) Feeders and branch circuits.
2) Lighting circuits.
3) Receptacle circuits.
4) Single-phase motor and appliance branch circuits.
5) Three-phase motor and appliance branch circuits.
6) Flexible raceway runs.
7) Armored and metal-clad cable runs.
8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9) X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
e. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
f. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway

and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

g. Poles Supporting Outdoor Lighting Fixtures: Bond insulated equipment grounding conductor to equipment grounding terminal inside pole base.

h. Metallic Fences: Comply with requirements of IEEE C2.

1) Grounding Conductor: Bare[**, tinned**] copper, not less than [**8 AWG**]<**Insert wire size**>.

2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.

3) Barbed Wire: Strands must be bonded to grounding conductor.

9. Fence Grounding:

a. Grounding Method: At each grounding location, drive grounding rod vertically until top is **6 inch (150 mm)** below finished grade. Connect rod to fence with 6 AWG conductor. Connect conductor to each fence component at grounding location.

b. Fences greater than **100 ft (30 m)** of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of [**1500 ft (450 m)**]<**Insert lesser distance if grounding resistance is high**>.

c. Fences within **100 ft (30 m)** of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of [**750 ft (225 m)**]<**Insert lesser distance if grounding resistance is high**>.

1) Gates and Other Fence Openings: Ground fence on each side of opening.

a) Bond metal gates to gate posts by connecting bonding jumper between gate post and gate frame.

b) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use 2 AWG wire and bury it at least **18 inch (460 mm)** below finished grade.

d. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of power line crossing and at maximum distance of **150 ft (45 m)** on each side of crossing.

e. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground fence and bond fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.6 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[**, at ground test wells**][**, and at individual ground rods**]. Make tests at ground rods before conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
    c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

F. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:

    a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: [**10 Ω**]<**Insert ohms**>.
    b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: [**5 Ω**]<**Insert ohms**>.
    c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: [**3 Ω**]<**Insert ohms**>.
    d. Power Distribution Units or Panelboards Serving Electronic Equipment: [**1 Ω**][**3 Ω**]<**Insert ohms**>.
    e. Substations and Pad-Mounted Equipment: [**5 Ω**]<**Insert ohms**>.
    f. Manhole Grounds: [**10 Ω**]<**Insert ohms**>.
    g. <**Insert application and maximum ground-resistance**>.

3.7 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 26 00

Task	Specification	Specification Description
26 05 26 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 29 00 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support systems.
2. Mounting, anchoring, and attachment components.
3. Installation of fabricated metal supports.
4. Installation of concrete bases.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 033000 "Cast-in-Place Concrete" specifies concrete materials, reinforcement, and placement requirements referenced by this Section.
5. Section 055000 "Metal Fabrications" specifies site-fabricated metal supports referenced by this Section.
6. [**Section 099113 "Exterior Painting"**][**Section 099123 "Interior Painting"**][**and**][**Section 099600 "High-Performance Coatings"**] specify cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal referenced by this Section.
7. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration controls, seismic restraints, and wind restraints referenced by this Section.

1.2 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals: Engage qualified structural professional engineer to design hangers and supports for electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.

f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.
j. <**Insert product type**>.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and shop drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.6 QUALIFICATIONS

A. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind controls, equipment hangers and supports, and concrete foundations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 018123 "Facility Seismic and Wind Criteria."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT SYSTEMS

A. Steel Slotted Support Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Allied Tube & Conduit; Atkore International**]
    c. [**Atkore Unistrut**]
    d. [**CADDY; brand of nVent Electrical plc**]
    e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    f. [**Flex-Strut Inc.**]
    g. [**G-Strut**]
    h. [**Gripple Inc.**]
    i. [**Haydon Corporation**]
    j. [**Metal Ties Innovation**]
    k. [**MIRO Industries Inc.**]
    l. [**Rocket Rack; Robroy Industries**]
    m. [**Wesanco/ZSi-Foster; an Ideal Tridon Group Company**]
    n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Allied Tube & Conduit; Atkore International**]
    c. [**Atkore Unistrut**]
    d. [**CADDY; brand of nVent Electrical plc**]
    e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    f. [**Flex-Strut Inc.**]
    g. [**G-Strut**]
    h. [**Gripple Inc.**]
    i. [**Haydon Corporation**]
    j. [**Metal Ties Innovation**]
    k. [**MIRO Industries Inc.**]
    l. [**Rocket Rack; Robroy Industries**]
    m. [**Wesanco/ZSi-Foster; an Ideal Tridon Group Company**]
    n. <**Insert manufacturer's name**>

3. Standard Features: Preformed steel channels and angles with minimum **13/32 inch (10 mm)** diameter holes at a maximum of **8 inch (200 mm)** on center in at least one surface.

    a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
    b. Material for Channel, Fittings, and Accessories: [**Galvanized steel**][**Plain steel**][**Stainless steel, Type 304**][**Stainless steel, Type 316**].
    c. Channel Width: [**Selected for applicable load criteria**][**1-5/8 inch (41.25 mm)**][**1-1/4 inch (31.75 mm)**][**13/16 inch (20.64 mm)**]<**Insert dimension**>.
    d. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

e. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
f. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
g. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Atkore Unistrut**]
c. [**Eaton**]
d. [**Flex-Strut Inc.**]
e. [**Haydon Corporation**]
f. [**MKT Metal Manufacturing**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Atkore Unistrut**]
c. [**Eaton**]
d. [**Flex-Strut Inc.**]
e. [**Haydon Corporation**]
f. [**MKT Metal Manufacturing**]
g. <**Insert manufacturer's name**>

3. Standard Features: Extruded-aluminum channels and angles with minimum **13/32 inch (10 mm)** diameter holes at a maximum of **8 inch (200 mm)** on center in at least one surface.

a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
b. Channel Material: 6063-T5 aluminum alloy.
c. Fittings and Accessories Material: 5052-H32 aluminum alloy.
d. Channel Width: [**Selected for applicable load criteria**][**1-5/8 inch (41.25 mm)**][**1-1/4 inch (31.75 mm)**][**13/16 inch (20.64 mm)**]<**Insert dimension**>.
e. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
f. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
g. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Nonmetallic Slotted Support Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Tube & Conduit; Atkore International**]

b. [**Atkore Unistrut**]
c. [**Champion Fiberglass, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Fabco Plastics Wholesale Limited**]
f. [**G-Strut**]
g. [**Haydon Corporation**]
h. [**Seasafe, Inc.; AMICO, a Gibraltar Industries Company**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Atkore Unistrut**]
c. [**Champion Fiberglass, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Fabco Plastics Wholesale Limited**]
f. [**G-Strut**]
g. [**Haydon Corporation**]
h. [**Seasafe, Inc.; AMICO, a Gibraltar Industries Company**]
i. <**Insert manufacturer's name**>

3. Standard Features: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum **13/32 inch (10 mm)** diameter holes at a maximum of **8 inch (200 mm)** on center, in at least one surface.

a. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
b. Channel Width: [**Selected for applicable load criteria**][**1-5/8 inch (41.25 mm)**][**1-1/4 inch (31.75 mm)**][**13/16 inch (20.64 mm)**]<**Insert dimension**>.
c. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
d. Fitting and Accessory Materials: Same as those for channels and angles[**, except metal items may be stainless steel**].
e. Rated Strength: Selected to suit applicable load criteria.
f. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices:

1. Standard Features: [**Steel**][**Steel and malleable-iron**][**Stainless steel**][**Glass-fiber-resin**] hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit:

1. Standard Features: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints:

1. Standard Features: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

2.3 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

A. Powder-Actuated Fasteners :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hilti, Inc.**]
   b. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   c. [**MKT Fastening, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hilti, Inc.**]
   b. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   c. [**MKT Fastening, LLC**]
   d. <**Insert manufacturer's name**>

3. Standard Features: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   b. [**Empire Industries, Inc.**]
   c. [**Hilti, Inc.**]
   d. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   e. [**MKT Fastening, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   b. [**Empire Industries, Inc.**]
   c. [**Hilti, Inc.**]
   d. [**ITW Ramset/Red Head; Illinois Tool Works, Inc.**]
   e. [**MKT Fastening, LLC**]
   f. <**Insert manufacturer's name**>

3. Standard Features: Insert-wedge-type, [**zinc-coated**][**stainless**] steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

C. Concrete Inserts:

1. Standard Features: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

D. Clamps for Attachment to Steel Structural Elements:

1. Standard Features: MSS SP-58 units are suitable for attached structural element.

E. Through Bolts:

1. Standard Features: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, **Grade A325 (Grade A325M)**.

F. Toggle Bolts:

1. Standard Features: [**All**][**Stainless**] steel springhead type.

G. Hanger Rods:

1. Standard Features: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION OF HANGERS AND SUPPORTS

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as [**required by**][**scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in**] NFPA 70. Minimum rod size must be **1/4 inch (6 mm)** in diameter.

B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted [**or other**]support system, sized so capacity can be increased by at least [**25**]<**Insert number**> percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with [**two-bolt conduit clamps**][**single-bolt conduit clamps**][**single-bolt conduit clamps using spring friction action for retention in support channel**].

C. Spring-steel clamps designed for supporting single conduits without bolts may be used for **1-1/2 inch (38 mm)** and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Hot Work: NFPA 51B.

3. Work in Confined Spaces: NFPA 350.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Installation of Steel Conduit: NECA NEIS 101.
6. Installation of Aluminum Conduit: NECA NEIS 102.
7. Installation of Metal Cable Tray Systems: NECA NEIS 105.
8. Installation of Nonmetallic Cable Tray Systems: NECA NEIS 111.
9. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Raceway Support Methods: In addition to methods described in NECA NEIS 1, [**EMT**][**IMC**][**and**][**ERMC**] may be supported by openings through structure members, in accordance with NFPA 70.
2. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus **200 lb (90 kg)**.
3. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

    a. To Wood: Fasten with lag screws or through bolts.
    b. To New Concrete: Bolt to concrete inserts.
    c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    d. To Existing Concrete: Expansion anchor fasteners.
    e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete **4 inch (100 mm)** thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than **4 inch (100 mm)** thick.
    f. To Steel: [**Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts**][**Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69**][**Spring-tension clamps**].
    g. To Light Steel: Sheet metal screws.
    h. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[**by means that comply with seismic-restraint strength and anchorage requirements**].

4. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

D. Interfaces with Other Work:

1. Provide [**vibration**][**and**][**seismic**] controls with hangers and supports.
2. Touchup Finishes:

    a. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

        1) Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils (0.05 mm)**.

    b. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of

shop paint on miscellaneous metal.

c. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3. Installation of Fabricated Metal Supports:

a. Provide site-fabricated metal supports.
b. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
c. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

4. Installation of Concrete Bases:

a. Provide concrete bases of dimensions indicated, but not less than **4 inch (100 mm)** larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
b. Use [**3000 psi (20.7 MPa)**]<**Insert value**>, 28-day compressive-strength concrete.
c. Anchor equipment to concrete base as follows:

1) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2) Install anchor bolts to elevations required for proper attachment to supported equipment.
3) Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 26 05 29 00

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Task	Specification	Specification Description
26 05 29 00	05 40 00 00	Cold-Formed Metal Framing
26 05 29 00	05 05 19 00	Metal Fabrications
26 05 29 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 33 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 33 13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type HDPE and Type EPEC duct raceways and fittings.
4. Type ERMC duct raceways, elbows, couplings, and nipples.
5. Type FMC duct raceways.
6. Type FMT duct raceways.
7. Type IMC duct raceways.
8. Type LFMC duct raceways.
9. Type LFNC duct raceways.
10. Type PVC duct raceways and fittings.
11. Type RTRC duct raceways and fittings.
12. Fittings for conduit, tubing, and cable.
13. Joint compounds.
14. Solvent cements.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies firestopping referenced by this Section.
5. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
6. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
7. Section 260543 "Underground Ducts and Raceways for Electrical Systems" specifies exterior duct banks, manholes, and underground utility construction.
8. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.
9. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for installation of conduits for communications cabling.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.

4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERMC: Electrical rigid metal conduit.
10. ERMC-A: Aluminum electrical rigid metal conduit.
11. ERMC-S: Steel electrical rigid metal conduit.
12. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERMC-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

B. Definitions:

1. Conduit: A structure containing one or more duct raceways.
2. Direct Buried: Installed underground without encasement in concrete or other protective material.
3. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
4. Duct Raceway: A single enclosed raceway for conductors or cable.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. ERMC-S-PVC Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by ERMC-S-PVC manufacturer prior to starting installation.

E. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <**Insert additional performance requirements for the Project**>.

2.2 TYPE EMT DUCT RACEWAYS AND ELBOWS

A. UL FJMX - Aluminum Electrical Metal Tubing (EMT-A) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
    b. [**Patriot Aluminum Products, LLC**]
    c. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
    b. [**Patriot Aluminum Products, LLC**]
    c. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN FJMX; including UL 797A.

4. Standard Features:

    a. Material: Aluminum.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL FJMX - Stainless Steel Electrical Metal Tubing (EMT-SS) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Calconduit; Atkore International**]
b. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Calconduit; Atkore International**]
b. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FJMX; including UL 797A.

4. Standard Features:

a. Material: Stainless steel.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Emerson Electric Co., Automation Solutions**]
d. [**Picoma; Zekelman Industries**]
e. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Emerson Electric Co., Automation Solutions**]
d. [**Picoma; Zekelman Industries**]
e. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FJMX; including UL 797.

4. Standard Features:

a. Material: Steel.
b. Exterior Coating: [**Zinc**][**Alternate corrosion-resistant coating**].
c. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
d. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.3 TYPE ENT DUCT RACEWAYS AND FITTINGS

A. UL FKHU - Electrical Nonmetallic Tubing (ENT) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Cantex Inc.**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cantex Inc.**]
c. [**JM Eagle**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FKHU; including UL 1653.

4. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

5. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade**

size 3/4)].

b. Fittings:

1) Mechanically Attached Fittings: UL 1653.
2) Solvent-Attached Fittings: UL 651.

2.4 TYPE HDPE AND TYPE EPEC DUCT RACEWAYS AND FITTINGS

A. UL EAZX - Schedule 40 Electrical HDPE Underground Conduit (HDPE-40):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Schedule 40.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

B. UL EAZX - Schedule 80 Electrical HDPE Underground Conduit (HDPE-80):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Schedule 80.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

C. UL EAZX - Type A Electrical HDPE Underground Conduit (EPEC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EAZX; including UL 651A.

4. Standard Features:

a. Dimensional Specifications: Type A.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

D. UL EAZX - Type B Electrical HDPE Underground Conduit (EPEC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN EAZX; including UL 651A.

4. Standard Features:

   a. Dimensional Specifications: Type B.

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.5 TYPE ERMC DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. UL DYWV - Aluminum Electrical Rigid Metal Conduit (ERMC-A), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
d. [**Appleton; Emerson Electric Co., Automation Solutions**]
e. [**Calconduit; Atkore International**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Patriot Aluminum Products, LLC**]
i. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
j. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
k. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
l. [**Topaz Lighting & Electric**]
m. [**Western Tube; Zekelman Industries**]
n. [**Wheatland Tube; Zekelman Industries**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC**]
d. [**Appleton; Emerson Electric Co., Automation Solutions**]
e. [**Calconduit; Atkore International**]
f. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Patriot Aluminum Products, LLC**]
i. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
j. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
k. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
l. [**Topaz Lighting & Electric**]
m. [**Western Tube; Zekelman Industries**]
n. [**Wheatland Tube; Zekelman Industries**]
o. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYWV; including UL 6A.

4. Standard Features:

a. Material: Aluminum.
b. Protective Coating: Provide protective coating for [**use in concrete**][**direct burial**][**use in severely corrosive environment**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability

report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL DYWV - Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYWV; including UL 6A.

4. Standard Features:

a. Material: Stainless steel.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Patriot Aluminum Products, LLC**]
f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
g. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
h. [**Topaz Lighting & Electric**]
i. [**Western Tube; Zekelman Industries**]
j. [**Wheatland Tube; Zekelman Industries**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Patriot Aluminum Products, LLC**]
f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
g. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
h. [**Topaz Lighting & Electric**]
i. [**Western Tube; Zekelman Industries**]
j. [**Wheatland Tube; Zekelman Industries**]
k. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYIX; including UL 6.

4. Standard Features:

a. Exterior Coating: Zinc.
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

D. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Bluesteel Services LLC**]
c. [**Calbond; Atkore International**]
d. [**KorKap; Robroy Industries**]
e. [**Perma-Cote; Robroy Industries**]
f. [**Plasti-Bond; Robroy Industries**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Bluesteel Services LLC**]
c. [**Calbond; Atkore International**]
d. [**KorKap; Robroy Industries**]

e. [**Perma-Cote; Robroy Industries**]
f. [**Plasti-Bond; Robroy Industries**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DYIX; including UL 6.

4. Standard Features:

   a. Exterior Coating: PVC complying with NEMA RN 1.
   b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
   c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.
   b. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
   c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.6 TYPE FMC DUCT RACEWAYS

A. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. [**International Metal Hose Co.**]
   e. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]

f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
c. [**Electri-Flex Company**]
d. [**International Metal Hose Co.**]
e. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXUZ; including UL 1.

4. Standard Features:

a. Material: Steel.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL DXUZ - Aluminum Flexible Metal Conduit (FMC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]

b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
c. [**Electri-Flex Company**]
d. [**Topaz Lighting & Electric**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
c. [**Electri-Flex Company**]
d. [**Topaz Lighting & Electric**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXUZ; including UL 1.

4. Standard Features:

a. Material: Aluminum.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.7 TYPE FMT DUCT RACEWAYS

A. UL ILJW - Steel Flexible Metallic Tubing (FMT):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Electri-Flex Company**]
b. [**International Metal Hose Co**]
c. [**Liquid Tight Connector Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Electri-Flex Company**]
b. [**International Metal Hose Co**]
c. [**Liquid Tight Connector Co.**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN ILJW; including UL Subject 1652.

4. Standard Features:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.8 TYPE IMC DUCT RACEWAYS

A. UL DYBY - Steel Intermediate Metal Conduit (IMC):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V**]
f. [**Topaz Lighting & Electric**]
g. [**Western Tube; Zekelman Industries**]
h. [**Wheatland Tube; Zekelman Industries**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYBY; including UL 1242.

4. Standard Features:

a. Exterior Coating: [**Zinc**][**Alternative corrosion-resistant coating**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Colors: As indicated on the Drawings.

2.9 TYPE LFMC DUCT RACEWAYS

A. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
    c. [**Electri-Flex Company**]
    d. [**International Metal Hose Co**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
    c. [**Electri-Flex Company**]
    d. [**International Metal Hose Co**]
    e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DXHR; including UL 360.

4. Standard Features:

    a. Material: Steel.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate

scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

   a. Colors: As indicated on the Drawings.

B. UL DXHR - Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Anaconda Sealtite; Anamet Electrical, Inc**]
   c. [**Electri-Flex Company**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXHR; including UL 360.

4. Standard Features:

   a. Material: Stainless steel.
   b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Colors: As indicated on the Drawings.

2.10 TYPE LFNC DUCT RACEWAYS

A. UL DXOQ - Layered (Type A) Liquidtight Flexible Nonmetallic Conduit (LFNC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**AFC Cable Systems; Atkore International**]
    b. [**Electri-Flex Company**]
    c. [**Topaz Lighting & Electric**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**AFC Cable Systems; Atkore International**]
    b. [**Electri-Flex Company**]
    c. [**Topaz Lighting & Electric**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

    a. Type A conduit with smooth seamless inner core and cover bonded together with one or more reinforcement layers between core and cover.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
    c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

B. UL DXOQ - Integral (Type B) Liquidtight Flexible Nonmetallic Conduit (LFNC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Cambridge Resources**]
c. [**Electri-Flex Company**]
d. [**Superflex Ltd.**]
e. [**Topaz Lighting & Electric**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cambridge Resources**]
c. [**Electri-Flex Company**]
d. [**Superflex Ltd.**]
e. [**Topaz Lighting & Electric**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

a. Type B conduit with smooth inner surface with integral reinforcement within conduit wall.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project

site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

C. UL DXOQ - Corrugated (Type C) Liquidtight Flexible Nonmetallic Conduit (LFNC-C):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**HellermannTyton**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**HellermannTyton**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DXOQ; including UL 1660.

4. Standard Features:

a. Type C conduit with corrugated internal and external surfaces without integral reinforcement within conduit wall.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**80 deg C dry**][**90 deg C dry**][**105 deg C dry**][**70 deg C oil resistant**][**Sunlight resistant**][**Outdoor**][**Direct burial**][**Complies with flame test in cable trays**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Colors: As indicated on the Drawings.

2.11 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**NAPCO; Westlake Chemical Corp.**]
e. [**National Pipe and Plastic, Inc. (Oldcastle)**]
f. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**NAPCO; Westlake Chemical Corp.**]
e. [**National Pipe and Plastic, Inc. (Oldcastle)**]
f. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Schedule 40.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**For use with maximum 90 deg C wire**][**For directional boring applications**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DZYR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**National Pipe and Plastic, Inc. (Oldcastle)**]
e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**National Pipe and Plastic, Inc. (Oldcastle)**]
e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Schedule 80.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Markings: [**For use with maximum 90 deg C wire**][**For directional boring applications**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL DZYR - Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Southern Pipe, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Southern Pipe, Inc.**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Type A.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL DZYR - Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JM Eagle**]
b. [**Southern Pipe, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**JM Eagle**]
b. [**Southern Pipe, Inc.**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZYR; including UL 651.

4. Standard Features:

a. Dimensional Specifications: Type EB.
b. Minimum Trade Size: [**Metric designator 53 (trade size 2)**][**Metric designator 78 (trade size 3)**][**Metric designator 103 (trade size 4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.12 TYPE RTRC DUCT RACEWAYS AND FITTINGS

A. UL DZKT - Heavy Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-HW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DZKT; including UL 2515.

4. Standard Features:

    a. Additional Characteristics: Type AG-HW.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DZKT - Standard Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-SW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Champion Fiberglass, Inc**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DZKT; including UL 2515.

4. Standard Features:

a. Additional Characteristics: Type SW.
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL DZKT - Extra Heavy Wall, Low-Halogen, Aboveground Reinforced Thermosetting Resin Conduit (RTRC-AG-XW) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Champion Fiberglass, Inc**]
b. [**FRE Composites**]
c. [**United Fiberglass of America (UFA)**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Champion Fiberglass, Inc**]
b. [**FRE Composites**]
c. [**United Fiberglass of America (UFA)**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DZKT; including UL 2515 and UL 2515A.

4. Standard Features:

    a. Additional Characteristics: Type AG-XW.
    b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL DZKT - Low-Halogen, Belowground Reinforced Thermosetting Resin Conduit (RTRC-BG) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Champion Fiberglass, Inc**]
    b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DZKT; including UL 2420.

4. Standard Features:

    a. Additional Characteristics: Type BG.

b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.13 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. UL EBMB - Duct Fittings for Hazardous (Classified) Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
b. [**Power Feed-Thru Systems and Connectors LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
b. [**Power Feed-Thru Systems and Connectors LLC**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN EBMB; including UL 1203.

4. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project

site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL DWTT - Fittings for Type ERMC, Type IMC, Type PVC, Type HDPE, Type EPEC, and Type RTRC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Konkore Fittings; Atkore International**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Konkore Fittings; Atkore International**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DWTT; including UL 514B.

4. Standard Features:

a. Material: [**Steel**][**Die cast**].
b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].

c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL FKAV - Fittings for Type EMT Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Calconduit; Atkore International**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Calconduit; Atkore International**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FKAV; including UL 514B.

4. Standard Features:

    a. Material: [**Steel**][**Die cast**].
    b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].
    c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL ILNR - Fittings for Type FMC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Fittings Corp. (AMFICO)**]
    b. [**Liquid Tight Connector Co.**]
    c. [**Southwire Company, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Fittings Corp. (AMFICO)**]
    b. [**Liquid Tight Connector Co.**]
    c. [**Southwire Company, LLC**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN ILNR; including UL 514B.

4. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts

of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arlington Industries, Inc.**]
   b. [**Liquid Tight Connector Co.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arlington Industries, Inc.**]
   b. [**Liquid Tight Connector Co.**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN DXAS; including UL 514B.

4. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.14 JOINT COMPOUNDS

A. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN FOIZ; including UL Subject 2419.

4. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.15 SOLVENT CEMENTS

A. UL VBEW - Solvent Cements for Nonmetallic Duct Raceways and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Solvent Cements: UL CCN VBEW; including UL 340.
b. Solvent Cement Compatibility with PVC Conduit Fittings: UL CCN DWTT; including UL 514B. Follow solvent manufacturer's published instructions.
c. Solvent Cement Compatibility with Rigid PVC Conduit: UL CCN DZYR; including UL 651. Follow solvent manufacturer's published instructions.
d. Solvent Cement Compatibility with Rigid EPEC and HDPE Underground Conduit: UL CCN EAZX; including UL 651A. Follow solvent manufacturer's published instructions.

4. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in the Contract Documents or manufacturer's published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE[**and EPEC**] underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE[**and Type EPEC**] underground conduits are not permitted to be used aboveground on the Project.

C. Outdoors:

1. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**].
2. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**].
3. Exposed and Not Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**][**PVC-80**][**RTRC-AG**].

4. Concealed Aboveground: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**PVC-40**][**RTRC-AG**].
5. Direct Buried: [**PVC-80**][**PVC-40**][**HDPE-80**][**HDPE-40**][**RTRC-BG**].
6. Concrete Encased Not in Trench: [**PVC-80**][**PVC-40**][**PVC-A**][**RTRC-BG**].
7. Concrete Encased in Trench: [**PVC-80**][**PVC-40**][**PVC-A**][**PVC-EB**][**HDPE-80**][**HDPE-40**][**EPEC-A**][**EPEC-B**][**RTRC-BG**].
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [**LFMC**][**LFNC-A**][**LFNC-B**].

D. Indoors:

1. Hazardous Classified Locations: [**ERMC**][**IMC**].
2. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**].
3. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**EMT**].
4. Exposed and Not Subject to Physical Damage: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**RTRC-AG**].
5. Concealed in Ceilings and Interior Walls and Partitions: [**ERMC**][**IMC**][**EMT**][**PVC-80**][**PVC-40**][**RTRC-AG**].
6. Damp or Wet Locations: [**ERMC**][**IMC**][**RTRC-AG**][**Corrosion-resistant EMT**].
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [**LFMC**][**FMC**][**LFNC-A**][**LFNC-B**].
8. Circuits Operating Above 60 Hz: [**EMT-A**][**ERMC-A**][**RTRC-AG**]. Provide nonmetallic sleeve where aluminum duct raceways pass through concrete.

E. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.
11. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.
12. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
13. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
14. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
15. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
16. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.
17. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
18. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
19. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
20. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
21. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.

22. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
23. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
24. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
25. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
26. Expansion Fittings: NEMA FB 2.40.
27. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

a. Complete duct raceway installation before starting conductor installation.
b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of **2 ft (0.6 m)** above finished floor.
c. Install no more than equivalent of three 90-degree bends in conduit run[**except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted**]. Support within **12 inch (300 mm)** of changes in direction.
d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
f. Support conduit within **12 inch (300 mm)** of enclosures to which attached.
g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:

1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2) Where an underground service duct raceway enters a building or structure.
3) Conduit extending from interior to exterior of building.
4) Conduit extending into pressurized duct raceway and equipment.
5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6) Where otherwise required by NFPA 70.

i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
j. Do not install conduits within **2 inch (50 mm)** of the bottom side of a metal deck roof.
k. Keep duct raceways at least **6 inch (150 mm)** away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than **200 lb (90 kg)** tensile strength. Leave at least **12 inch (300 mm)** of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

1) Termination fittings with shoulders do not require two locknuts.

o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts.[**Install insulated throat metal grounding bushings on service conduits**].

2. Types EMT-A, ERMC-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
3. Types ERMC and IMC:

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

4. Type ERMC-S-PVC:

a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.
c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

5. Types FMC, LFMC, and LFNC:

a. Provide a maximum of [**36 inch (915 mm)**][**72 inch (1830 mm)**] of flexible conduit for [**recessed and semirecessed luminaires,**]equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

6. Types PVC, HDPE, and EPEC:

a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds [**122 deg F (50 deg C)**]<**Insert temperature**>. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
b. Comply with manufacturer's published instructions for solvent welding and fittings.
c. Join joints with solvent cement in accordance with manufacturer's published instructions and allowed to cure before handling. Joints to be bent, pushed, or pulled must set for minimum 24 h after joining.

7. Type RTRC: Do not install Type RTRC conduit where ambient temperature exceeds [**230 deg F (110 deg C)**]<**Insert temperature**>.
8. Duct Raceways Embedded in Slabs:

a. [**Run duct raceways larger than metric designator 27 (trade size 1) below concrete slab**][**Run duct raceways larger than metric designator 27 (trade size) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place duct raceway close to slab support. Secure duct raceways to reinforcement at maximum 10 ft (3 m) intervals**].
b. Arrange duct raceways to cross building expansion joints with expansion fittings at right

angles to the joint.

c. Arrange duct raceways to ensure that each is surrounded by minimum of [**1 inch (25 mm)**][**2 inch (50 mm)**]<**Insert dimension**> of concrete without voids.

d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.

e. Change from ENT to [**PVC-80**][**PVC-40**][**ERMC**][**or**][**IMC**] before rising above floor.

9. Stub-ups to Above Recessed Ceilings:

a. Provide EMT, IMC, or ERMC for duct raceways.

b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

10. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.[**Install insulated throat metal grounding bushings on service conduits**].

11. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

a. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

b. EMT: Provide [**setscrew**][**compression**], [**steel**][**cast-metal**] fittings. Comply with NEMA FB 2.10.

c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

12. Expansion-Joint Fittings:

a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed **30 deg F (17 deg C)** and that have straight-run length that exceeds **25 ft (7.6 m)**. Install in runs of aboveground ERMC[**and EMT**] conduit that are located where environmental temperature change may exceed **100 deg F (55 deg C)** and that have straight-run length that exceeds **100 ft (30 m)**.

b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: [**125 deg F (70 deg C)**]<**Insert temperature**> temperature change.

2) Outdoor Locations Exposed to Direct Sunlight: [**155 deg F (86 deg C)**]<**Insert temperature**> temperature change.

3) Indoor Spaces Connected with Outdoors without Physical Separation: [**125 deg F (70 deg C)**]<**Insert temperature**> temperature change.

4) Attics: [**135 deg F (75 deg C)**]<**Insert temperature**> temperature change.

5) <**Insert location and corresponding temperature change**>.

c. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C)** of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least **0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C)** of temperature change for metal conduits.

d. Install expansion fittings at locations where conduits cross building or structure expansion joints.

e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

13. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty[**or firestopping**].
14. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

    a. Provide warning signs.

15. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturer's published instructions**>.

D. Interfaces with Other Work:

1. Firestop penetrations of fire-rated floor and wall assemblies.
2. Provide conduit hangers and supports.
3. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

4. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

3.3 FIELD QUALITY CONTROL OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum **12 inch (300 mm)** long mandrel equal to duct size minus **1/4 inch (6 mm)**. If obstructions are indicated, remove obstructions and retest.
3. Conduit Placement:

    a. Verify that center-line location and offsets are in accordance with the Drawings.
    b. Verify that hangers and supports for conduits are attached to structure [**in accordance with the Drawings**][**as directed by qualified structural engineer**].
    c. Verify that nuts on bolts or hanger rods are secure.
    d. Verify that space between raceways and cored holes are filled with non-shrinking grout or other approved material indicated on the Drawings and the Specifications.
    e. Verify that expansion devices are installed at locations indicated on the Drawings and the Specifications.
    f. Verify that ends are cut square to provide flush-butting surfaces when spliced and inside edges are free of burrs that could impede installation of cables.
    g. Verify minimum separation of utilities, or that approved mechanical protection has been provided to surrounding conduit(s) where minimum separation cannot be achieved.

4. Document all changes on Record Drawings.

F. Nonconforming Work:

1. Conduit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Verify that bentonite or other drilling fluids are contained and removed, and site is restored to its original or improved condition.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33 13

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Task	Specification	Specification Description
26 05 33 13	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 33 13	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 33 13	27 11 00 00	Communications Equipment Room Fittings
26 05 33 13	27 13 13 00	Communications Copper Backbone Cabling
26 05 33 13	27 15 33 00	Communications Coaxial Horizontal Cabling

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SECTION 26 05 33 16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
8. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for identification of communications equipment and cabling.

1.2 DEFINITIONS

A. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.

B. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

1. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
2. Concrete Box: A box intended for use in poured concrete.
3. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
4. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.

5. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
6. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
7. Device Box: A box with provisions for mounting a wiring device directly to the box.
8. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
9. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
10. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
11. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
12. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
13. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
14. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
15. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
16. Raised-Floor Box: A floor box intended for use in raised floors.
17. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
18. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
19. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
20. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
21. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

C. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.

D. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product requiring samples for source quality control.

C. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness [**at location**]where boxes are embedded in

concrete floors and underfloor clearances where boxes are installed in raised floors.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and prepare related records and reports.

D. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke control interfaces, air sampling systems, multi-zone voice evacuation systems, or high-rise applications) and prepare related records and reports.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

F. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

G. Security Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

H. Fire-Alarm Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician **[I][II]** certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. <**Insert additional performance requirements for the Project**>.

2.2 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Source Quality Control:

1. Samples:

a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

B. UL QCIT - Metallic Outlet Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arlington Industries, Inc.**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**MonoSystems, Inc**]
i. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
j. [**Pass & Seymour; Legrand North America, LLC**]
k. [**Patriot Aluminum Products, LLC**]
l. [**Plasti-Bond; Robroy Industries**]

m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. [**Spring City Electrical Manufacturing Company**]
o. [**Topaz Lighting & Electric**]
p. [**Wiremold; Legrand North America, LLC**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arlington Industries, Inc.**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**MonoSystems, Inc**]
i. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
j. [**Pass & Seymour; Legrand North America, LLC**]
k. [**Patriot Aluminum Products, LLC**]
l. [**Plasti-Bond; Robroy Industries**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. [**Spring City Electrical Manufacturing Company**]
o. [**Topaz Lighting & Electric**]
p. [**Wiremold; Legrand North America, LLC**]
q. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT; including UL 514A.

4. Standard Features:

a. Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
b. Material: [**Sheet steel**][**Sheet aluminum**][**Cast metal**].
c. Sheet Metal Depth: Minimum [**1.5 inch (38 mm)**][**2 inch (50 mm)**][**2.5 inch (65 mm)**][**2.8 inch (70 mm)**][**3.5 inch (90 mm)**].
d. Cast-Metal Depth: Minimum [**1.8 inch (44.5 mm)**][**2.4 inch (60.3 mm)**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (lgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing [**up to 50 lb (23 kg)**][**more than 50 lb (23 kg) and marked with maximum allowable weight**].
b. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to **70 lb (32 kg)**.

C. UL QCIT - Metallic Conduit Bodies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Pass & Seymour; Legrand North America, LLC**]
g. [**Patriot Aluminum Products, LLC**]
h. [**Plasti-Bond; Robroy Industries**]
i. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Topaz Lighting & Electric**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Pass & Seymour; Legrand North America, LLC**]
g. [**Patriot Aluminum Products, LLC**]
h. [**Plasti-Bond; Robroy Industries**]
i. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Topaz Lighting & Electric**]
k. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT; including UL 514A.

4. Standard Features: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL QCIT - Metallic Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Arlington Industries, Inc.**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    h. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    i. [**Patriot Aluminum Products, LLC**]
    j. [**Plasti-Bond; Robroy Industries**]
    k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    l. [**Topaz Lighting & Electric**]
    m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Arlington Industries, Inc.**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    h. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]

i. [**Patriot Aluminum Products, LLC**]
j. [**Plasti-Bond; Robroy Industries**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Topaz Lighting & Electric**]
m. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT; including UL 514A.

4. Standard Features:

   a. Box with provisions for mounting wiring device directly to box.
   b. Material: [**Sheet steel**][**Sheet aluminum**][**Cast metal**].
   c. Sheet Metal Depth: minimum [**1.5 inch (38 mm)**][**2 inch (50 mm)**][**2.5 inch (65 mm)**][**2.8 inch (70 mm)**][**3.5 inch (90 mm)**].
   d. Cast-Metal Depth: minimum [**1.8 inch (44.5 mm)**][**2.4 inch (60.3 mm)**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL QCIT - Metallic Extension Rings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   g. [**Pass & Seymour; Legrand North America, LLC**]
   h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. [**Topaz Lighting & Electric**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
    e. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    f. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    g. [**Pass & Seymour; Legrand North America, LLC**]
    h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    i. [**Topaz Lighting & Electric**]
    j. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN QCIT; including UL 514A.

4. Standard Features: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL QCIT - Metallic Floor Boxes and Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**AFC Cable Systems; Atkore International**]
    c. [**Arlington Industries, Inc.**]
    d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
    e. [**FSR Inc.**]
    f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

h. [**Leviton Manufacturing Co., Inc.**]
i. [**Pass & Seymour; Legrand North America, LLC**]
j. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Wiremold; Legrand North America, LLC**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**AFC Cable Systems; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**FSR Inc.**]
f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Leviton Manufacturing Co., Inc.**]
i. [**Pass & Seymour; Legrand North America, LLC**]
j. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Wiremold; Legrand North America, LLC**]
l. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT; including UL 514A.

4. Standard Features: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL QCIT - Metallic Raised-Floor Boxes and Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT; including UL 514A.

4. Standard Features: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

H. UL QCIT - Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**FSR Inc.**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Wiremold; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**ABB, Electrification Business**]
b. [**FSR Inc.**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Wiremold; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT; including UL 514A.

4. Standard Features: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

I. UL QCIT - Metallic Concrete Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   e. [**Topaz Lighting & Electric**]
   f. [**Wiremold; Legrand North America, LLC**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]

b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Topaz Lighting & Electric**]
f. [**Wiremold; Legrand North America, LLC**]
g. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCIT; including UL 514A.

4. Standard Features: Box intended for use in poured concrete.
5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.3 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Source Quality Control:

1. Samples:

   a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
   b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
   c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
   d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

B. UL QCMZ - Nonmetallic Outlet Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]

c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Arlington Industries, Inc.**]
e. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
f. [**Cantex Inc.**]
g. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
h. [**Ericson Manufacturing Company**]
i. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Intermatic, Inc**]
l. [**JM Eagle**]
m. [**Leviton Manufacturing Co., Inc.**]
n. [**Panduit Corp**]
o. [**Pass & Seymour; Legrand North America, LLC**]
p. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
q. [**Topaz Lighting & Electric**]
r. [**Wiremold; Legrand North America, LLC**]
s. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Arlington Industries, Inc.**]
e. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
f. [**Cantex Inc.**]
g. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
h. [**Ericson Manufacturing Company**]
i. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Intermatic, Inc**]
l. [**JM Eagle**]
m. [**Leviton Manufacturing Co., Inc.**]
n. [**Panduit Corp**]
o. [**Pass & Seymour; Legrand North America, LLC**]
p. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
q. [**Topaz Lighting & Electric**]
r. [**Wiremold; Legrand North America, LLC**]
s. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly

to box.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL QCMZ - Nonmetallic Conduit Bodies:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**JM Eagle**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Topaz Lighting & Electric**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**JM Eagle**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Topaz Lighting & Electric**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies

are listed in accordance with outlet box requirements.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL QCMZ - Nonmetallic Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Pass & Seymour; Legrand North America, LLC**]
   h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Allied Tube & Conduit; Atkore International**]
   c. [**Arlington Industries, Inc.**]
   d. [**Cantex Inc.**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Pass & Seymour; Legrand North America, LLC**]
   h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box with provisions for mounting wiring device directly to box.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL QCMZ - Nonmetallic Extension Rings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**Cantex Inc.**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**Cantex Inc.**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL QCMZ - Nonmetallic Floor Boxes and Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Cantex Inc.**]
e. [**JM Eagle**]
f. [**Pass & Seymour; Legrand North America, LLC**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Wiremold; Legrand North America, LLC**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Arlington Industries, Inc.**]
d. [**Cantex Inc.**]
e. [**JM Eagle**]
f. [**Pass & Seymour; Legrand North America, LLC**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Wiremold; Legrand North America, LLC**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

G. UL QCMZ - Nonmetallic Raised-Floor Boxes and Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

H. UL QCMZ - Nonmetallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Leviton Manufacturing Co., Inc.**]
   e. [**Pass & Seymour; Legrand North America, LLC**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Wiremold; Legrand North America, LLC**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Leviton Manufacturing Co., Inc.**]
   e. [**Pass & Seymour; Legrand North America, LLC**]
   f. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Wiremold; Legrand North America, LLC**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts

of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

I. UL QCMZ - Nonmetallic Floor Nozzles:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Enclosure intended primarily as housing for receptacle, provided with means, such as collar, for surface-mounting on floor, which may or may not include stem to support it above floor level, and is sealed against the entrance of scrub water at floor level.
5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

J. UL QCMZ - Nonmetallic Concrete Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Allied Tube & Conduit; Atkore International**]
    c. [**Arlington Industries, Inc.**]
    d. [**Cantex Inc.**]
    e. [**JM Eagle**]
    f. [**Leviton Manufacturing Co., Inc.**]
    g. [**Wiremold; Legrand North America, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Allied Tube & Conduit; Atkore International**]
    c. [**Arlington Industries, Inc.**]
    d. [**Cantex Inc.**]
    e. [**JM Eagle**]
    f. [**Leviton Manufacturing Co., Inc.**]
    g. [**Wiremold; Legrand North America, LLC**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN QCMZ; including UL 514C.

4. Standard Features: Box intended for use in poured concrete.
5. Sustainable Design Features:

    a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
    b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.4 JUNCTION BOXES AND PULL BOXES

A. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adalet; division of Scott Fetzer Co.**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**FSR Inc.**]
e. [**Hoffman; brand of nVent Electrical plc**]
f. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Milbank Manufacturing Company**]
i. [**N J Sullivan Company**]
j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Spring City Electrical Manufacturing Company**]
m. [**Square D; Schneider Electric USA**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Adalet; division of Scott Fetzer Co.**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**FSR Inc.**]
e. [**Hoffman; brand of nVent Electrical plc**]
f. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Milbank Manufacturing Company**]
i. [**N J Sullivan Company**]
j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Spring City Electrical Manufacturing Company**]
m. [**Square D; Schneider Electric USA**]
n. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

a. Box with a blank cover that serves the purpose of joining different runs of raceway or

cable.
b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL BGUZ - Indoor Cast-Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Adalet; division of Scott Fetzer Co.**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Adalet; division of Scott Fetzer Co.**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL BGUZ - Indoor Polymeric Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Cantex Inc.**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**JM Eagle**]
f. [**Robroy Enclosures; Robroy Industries**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Cantex Inc.**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**JM Eagle**]
f. [**Robroy Enclosures; Robroy Industries**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

    a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
    b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Adalet; division of Scott Fetzer Co.**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    d. [**FSR Inc.**]
    e. [**Hoffman; brand of nVent Electrical plc**]
    f. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    h. [**Milbank Manufacturing Company**]
    i. [**N J Sullivan Company**]
    j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
    k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    l. [**Spring City Electrical Manufacturing Company**]
    m. [**Square D; Schneider Electric USA**]
    n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Adalet; division of Scott Fetzer Co.**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    d. [**FSR Inc.**]
    e. [**Hoffman; brand of nVent Electrical plc**]
    f. [**Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

h. [**Milbank Manufacturing Company**]
i. [**N J Sullivan Company**]
j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Spring City Electrical Manufacturing Company**]
m. [**Square D; Schneider Electric USA**]
n. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

   a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

E. UL BGUZ - Outdoor Cast-Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Adalet; division of Scott Fetzer Co.**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Adalet; division of Scott Fetzer Co.**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]

c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

F. UL BGUZ - Outdoor Polymeric Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Cantex Inc.**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**JM Eagle**]
f. [**Robroy Enclosures; Robroy Industries**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]

b. [**Allied Tube & Conduit; Atkore International**]
c. [**Cantex Inc.**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**JM Eagle**]
f. [**Robroy Enclosures; Robroy Industries**]
g. [**Topaz Lighting & Electric**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN BGUZ; including UL 50 and UL 50E.

4. Standard Features:

   a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 COVER PLATES FOR DEVICE BOXES

A. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Intermatic, Inc**]
h. [**Leviton Manufacturing Co., Inc.**]
i. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
j. [**Panduit Corp**]
k. [**Pass & Seymour; Legrand North America, LLC**]
l. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
m. [**Topaz Lighting & Electric**]
n. [**Wiremold; Legrand North America, LLC**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Intermatic, Inc**]
h. [**Leviton Manufacturing Co., Inc.**]
i. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
j. [**Panduit Corp**]
k. [**Pass & Seymour; Legrand North America, LLC**]
l. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
m. [**Topaz Lighting & Electric**]
n. [**Wiremold; Legrand North America, LLC**]
o. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

4. Standard Features:

a. Cover plate-Securing Screws: Metal with head color to match cover plate finish.
b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
c. Cover Plate Material: [**0.032 inch (0.8 mm) thick, Type 302/304 non-magnetic stainless steel with brushed finish**][**0.040 inch (1.0 mm) thick aluminum, anodized or lacquered to prevent corrosion**][**0.04 inch (1 mm) thick, brushed brass with factory polymer finish**][**Steel with white baked enamel, suitable for field painting**][**0.04 inch (1 mm) thick steel with chrome-plated finish**][**Galvanized steel**][**Cast aluminum**][**As indicated on architectural Drawings**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability

report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL QCIT or QCMZ - Nonmetallic Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Intermatic, Inc**]
i. [**Leviton Manufacturing Co., Inc.**]
j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
k. [**Panduit Corp**]
l. [**Pass & Seymour; Legrand North America, LLC**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. [**Topaz Lighting & Electric**]
o. [**Wiremold; Legrand North America, LLC**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Arlington Industries, Inc.**]
d. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Intermatic, Inc**]
i. [**Leviton Manufacturing Co., Inc.**]
j. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
k. [**Panduit Corp**]

l. [**Pass & Seymour; Legrand North America, LLC**]
m. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
n. [**Topaz Lighting & Electric**]
o. [**Wiremold; Legrand North America, LLC**]
p. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

4. Standard Features:

a. Cover Plate-Securing Screws: Metal with head color to match cover plate finish.
b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
c. Cover Plate Material: [**0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device**][**As indicated on architectural Drawings**].
d. Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].

5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL QCIT or QCMZ - Illuminating Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Leviton Manufacturing Co., Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Leviton Manufacturing Co., Inc.**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

4. Standard Features:

a. Cover Plate-Securing Screws: Metal with head color to match cover plate finish.
b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
c. Cover Plate Material: [**0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device**][**As indicated on architectural Drawings**].
d. Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].

5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.6 HOODS FOR OUTLET BOXES

A. UL QCIT or QCMZ - Retractable or Reattachable Hoods for Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

4. Standard Features:

a. Mounts to box using fasteners different from wiring device.
b. Provides [**clear**][**gray**][**white**], weatherproof, "while-in-use" cover.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
d. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Arlington Industries, Inc.**]
e. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
f. [**Intermatic, Inc**]
g. [**Leviton Manufacturing Co., Inc.**]
h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Appleton; Emerson Electric Co., Automation Solutions**]
d. [**Arlington Industries, Inc.**]

e. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
f. [**Intermatic, Inc**]
g. [**Leviton Manufacturing Co., Inc.**]
h. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

4. Standard Features:

a. Mounts to box using fasteners different from wiring device.
b. Marked "Extra-Duty" in accordance with UL 514D.
c. Provides [**clear**][**gray**][**white**], weatherproof, "while-in-use" cover.
d. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. [**Type 3**][**Type 3R**][**Type 4**] unless otherwise indicated.
b. Locations Exposed to Hosedown: [**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].
c. Locations Subject to Potential Flooding: Type 6P.
d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.

e. Locations in-Ground or Exposed to Corrosive Agents: [**Type 4X**][**Type 6P**][**Type 3RX**].
f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.
b. Damp or Dusty Locations: [**Type 12**][**Type 2**][**Type 4**][**Type 5**].
c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: [**Type 12**][**Type 12K**].
e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: [**Type 4**][**Type 6**].
f. Locations Exposed to Hosedown: [**Type 4**][**Type 6**][**Type 6P**].
g. Locations Exposed to Brief Submersion: [**Type 6**][**Type 6P**].
h. Locations Exposed to Prolonged Submersion: Type 6P.
i. Locations Exposed to Corrosive Agents: [**Type 4X**][**Type 6P**].
j. Locations Exposed to Spraying Oil or Coolants: Type 13.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:

1. [**Provide cast-metal boxes**][**Boxes with knockouts or unprotected openings are prohibited**].
2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to [**center**][**top**][**bottom**] of box unless otherwise indicated.
3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same

vertical channel.

5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

    a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
    b. Provide gaskets for cover plates and covers.

14. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Identification: Provide labels for boxes and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

3.3 FIELD QUALITY CONTROL OF BOXES AND COVERS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to

administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

D. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

E. Acceptance Testing Preparation:

1. <**Insert requirements**>.

F. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

G. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.

H. Nonconforming Work:

1. Boxes and covers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

I. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Remove construction dust and debris from boxes before installing cover plates, covers, and hoods.

3.5 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 33 16

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Task	Specification	Specification Description
26 05 33 16	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 33 16	26 27 26 00	Wiring Devices

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SECTION 26 05 33 23 - SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface metal raceways and fittings.
2. Surface nonmetallic raceways.
3. Strut-type channel raceways and fittings.
4. Wireways and auxiliary gutters.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies warning signs referenced by this Section.
6. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product requiring samples for source quality control.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.4 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment

data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 SURFACE METAL RACEWAYS AND FITTINGS

A. Source Quality Control:

1. Samples:

a. Surface Metallic Raceway Nonmetallic Cover Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [**12 inch (300 mm)**]<**Insert dimension**> long.

B. UL RJBT - Surface Metal Raceways and Fittings with Metal Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**MonoSystems, Inc**]
c. [**Wiremold; Legrand North America, LLC**]

d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**MonoSystems, Inc**]
   c. [**Wiremold; Legrand North America, LLC**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN RJBT; including UL 5.

4. Standard Features:

   a. [**Galvanized steel**][**Aluminum**] base with snap-on covers.
   b. [**Manufacturer's standard enamel finish in color selected by Architect**][**Prime coated, ready for field painting**].
   c. Wiring Channels: [**Single**][**Dual**][**Triple**]. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL RJBT - Surface Metal Raceways and Fittings with Nonmetallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Union Products International, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Union Products International, Inc.**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN RJBT; including UL 5.

4. Standard Features:

a. UL 94, V-0 requirements for self-extinguishing characteristics.
b. [**Galvanized steel**][**Aluminum**] base with snap-on covers.
c. Provide texture and color selected by Architect from [**manufacturer's standard**][**custom**] colors.
d. Wiring Channels: [**Single**][**Dual**][**Triple**]. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.3 SURFACE NONMETALLIC RACEWAYS

A. Source Quality Control:

1. Samples:

a. Surface Nonmetallic Raceway Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [**12 inch (300 mm)**]<**Insert dimension**> long.

B. UL RJTX - Surface Nonmetallic Raceways and Fittings with Nonmetallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HellermannTyton**]

b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Panduit Corp**]
e. [**Wiremold; Legrand North America, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**HellermannTyton**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Panduit Corp**]
e. [**Wiremold; Legrand North America, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN RJTX; including UL 5A.
b. UL 94, V-0 requirements for self-extinguishing characteristics.

4. Standard Features:

a. Provide texture and color selected by Architect from [**manufacturer's standard**][**custom**] colors.
b. Wiring Channels: [**Single**][**Dual**]. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL RJTX - Surface Nonmetallic Raceways and Fittings with Metallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN RJTX; including UL 5A.
b. UL 94, V-0 requirements for self-extinguishing characteristics.

4. Standard Features:

a. [**Manufacturer's standard enamel finish in color selected by Architect**][**Prime coated, ready for field painting**].
b. Wiring Channels: [**Single**][**Dual**]. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.4 STRUT-TYPE CHANNEL RACEWAYS AND FITTINGS

A. Source Quality Control:

1. Samples:

a. Strut-Type Channel Raceway Nonmetallic Covers for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [**12 inch (300 mm)**]<**Insert dimension**> long.

B. UL RIUU - Strut-Type Channel Raceways and Fittings with Metallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Atkore Unistrut**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Power-Strut; Atkore International**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Atkore Unistrut**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Power-Strut; Atkore International**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN RIUU; including UL 5B.

4. Standard Features:

   a. [**Manufacturer's standard enamel finish in color selected by Architect**][**Prime coated, ready for field painting**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL RIUU - Strut-Type Channel Raceways and Fittings with Nonmetallic Covers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN RIUU; including UL 5B.
b. UL 94, V-0 requirements for self-extinguishing characteristics.

4. Standard Features:

a. UL 94, V-0 requirements for self-extinguishing characteristics.
b. Provide texture and color selected by Architect from [**manufacturer's standard**][**custom**] colors.

5. Sustainable Design Features:

a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 WIREWAYS AND AUXILIARY GUTTERS

A. Source Quality Control:

1. Samples:

a. Nonmetallic Wireway and Auxiliary Gutter Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, [**12 inch (300 mm)**]<**Insert dimension**> long.

B. UL ZOYX - Metal Wireways and Auxiliary Gutters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABB, Electrification Business**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hoffman; brand of nVent Electrical plc**]
d. [**MonoSystems, Inc**]
e. [**Square D; Schneider Electric USA**]
f. [**Wiegmann; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Cooper B-line; brand of Eaton, Electrical Sector**]
c. [**Hoffman; brand of nVent Electrical plc**]
d. [**MonoSystems, Inc**]
e. [**Square D; Schneider Electric USA**]
f. [**Wiegmann; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN ZOYX; including UL 870.

4. Standard Features:

a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
b. Finish: Manufacturer's standard enamel finish.
c. Wireway Covers: [**Hinged type**][**Screw-cover type**][**Flanged-and-gasketed type**] unless otherwise indicated.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Degree of Protection: [**Type 1**][**Type 3R**][**Type 4**][**Type 12**]<**Insert type**> unless otherwise

indicated.

C. UL ZOYX - Nonmetallic Wireways and Auxiliary Gutters:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hoffman; brand of nVent Electrical plc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hoffman; brand of nVent Electrical plc**]
   b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. UL CCN ZOYX; including UL 870.
   b. UL 94, V-0 requirements for self-extinguishing characteristics.

4. Standard Features:

   a. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings must match and mate with wireways as required for complete system.
   b. PVC Solvents and Adhesives: As recommended by wireway manufacturer.
   c. Material:

      1) Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover must be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections must be flanged and have stainless steel screws and oil-resistant gaskets.
      2) PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

5. Sustainable Design Features:

   a. Solvent cements for use with nonmetallic raceways and covers have VOC content less than [**510**][**490**] g/L.
   b. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
   c. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
   d. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
   e. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.

f. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in Confined Spaces: NFPA 350.
6. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
7. Auxiliary Gutters: Article 366 of NFPA 70.
8. Surface Metal Raceway: Article 386 of NFPA 70.
9. Surface Nonmetallic Raceway: Article 388 of NFPA 70.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install surface raceways only where indicated on Drawings.
2. Install surface raceway with a minimum **2 inch (50 mm)** radius control at bend points.
3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding **48 inch (1200 mm)** and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's published instructions. Tape and glue are unacceptable support methods.
4. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Identification: Provide labels for surface raceways and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Provide warning signs.

2. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

   a. <**Insert requirements for transition between this Section and related Work**>.

3.2 FIELD QUALITY CONTROL OF SURFACE RACEWAYS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.

E. Nonconforming Work:

1. Boxes and covers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.3 CLEANING

A. Remove construction dust and debris from surface raceways before installing covers.

3.4 PROTECTION

A. After installation, protect surface raceways from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 33 23

Task	Specification	Specification Description
26 05 33 23	26 05 39 00	Underfloor Raceways For Electrical Systems
26 05 33 23	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 36 00 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal cable trays.
2. Nonmetallic cable trays.
3. Cable tray accessories.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

C. Products Installed, but Not Furnished, under This Section:

1. Section 078413 "Penetration Firestopping" specifies firestopping products installed under this Section.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding products installed under this Section.
3. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metal cable trays.
2. Nonmetallic cable trays.
3. Cable tray accessories.

B. Shop Drawings:

1. Cable tray fabrication drawings, diagrams, and supporting documents.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory test reports.

2. Manufacturer's field reports for field quality-control support.

PART 2 - PRODUCTS

2.1 METAL CABLE TRAYS

A. Description: This product category covers metal cable trays and metal cable tray systems intended for field assembly and for use in accordance with Article 392 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN CYNW; including NEMA VE 1 and suitability for use as equipment grounding conductors in accordance with Sections 392.60(A) and 392.60(B) of NFPA 70.

C. UL CYNW - Ladder Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Atkore Cope**]
c. [**BASOR Electric**]
d. [**Chalfant Manufacturing Company**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Hoffman; brand of nVent Electrical plc**]
g. [**MonoSystems, Inc**]
h. [**MP Husky USA Cable Tray & Cable Bus**]
i. [**Niedax Inc.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Atkore Cope**]
c. [**BASOR Electric**]
d. [**Chalfant Manufacturing Company**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Hoffman; brand of nVent Electrical plc**]
g. [**MonoSystems, Inc**]
h. [**MP Husky USA Cable Tray & Cable Bus**]
i. [**Niedax Inc.**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

    a. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
    b. Radius-Fitting Rung Spacing: **9 inch (225 mm)** at center of tray's width.
    c. Minimum Cable-Bearing Surface for Rungs: **7/8 inch (22 mm)** width with radius edges.
    d. No portion of the rungs must protrude below the bottom plane of side rails.
    e. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a **200 lb. (90 kg)** concentrated load, when tested in accordance with NEMA VE 1.
    f. Splicing Assemblies: Bolted type using serrated flange locknuts.
    g. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

    a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
    b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
    c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
    d. Finish:

        1) Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316**] hardware.
        2) Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
        3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
        4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

            a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
            b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
            c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

        5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
        6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
        7) <**Insert finish**>.

6. Materials and Finishes (Aluminum):

    a. Materials: Alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
    b. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].
    c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Materials and Finishes (Stainless Steel):

   a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**][**or**][**Type 316L**], ASTM F593 and ASTM F594.
   b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

8. Options:

   a. Width: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**][**36 inch (900 mm)**] unless otherwise indicated on Drawings.
   b. Minimum Usable Load Depth: [**3 inch (75 mm)**][**4 inch (100 mm)**][**5 inch (125 mm)**][**6 inch (150 mm)**].
   c. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**][**20 ft (6.0 m)**][**24 ft (7.4 m)**], except where shorter lengths are required to facilitate tray assembly.
   d. Rung Spacing: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**] on center.
   e. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**][**36 inch (900 mm)**][**48 inch (1200 mm)**].
   f. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
   g. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

D. UL CYNW - Wire-Mesh Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Atkore Cope**]
   b. [**BASOR Electric**]
   c. [**Cablofil; Legrand North America, LLC**]
   d. [**Chalfant Manufacturing Company**]
   e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   f. [**Enduro Composites Inc.**]
   g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   h. [**MonoSystems, Inc**]
   i. [**MP Husky USA Cable Tray & Cable Bus**]
   j. [**Niedax Inc.**]
   k. [**Snaketray**]
   l. [**WBT LLC**]
   m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Atkore Cope**]
   b. [**BASOR Electric**]
   c. [**Cablofil; Legrand North America, LLC**]

d. [**Chalfant Manufacturing Company**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Enduro Composites Inc.**]
g. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**MonoSystems, Inc**]
i. [**MP Husky USA Cable Tray & Cable Bus**]
j. [**Niedax Inc.**]
k. [**Snaketray**]
l. [**WBT LLC**]
m. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

a. Configuration: [**Galvanized-**]steel wire mesh, complying with NEMA VE 1.
b. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a **200 lb. (90 kg)** concentrated load, when tested in accordance with NEMA VE 1.
c. Splicing Assemblies: Bolted type using serrated flange locknuts.
d. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
d. Finish:

1) Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316**] hardware.
2) Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
7) <**Insert finish**>.

6. Options:

a. Width: [2 inch (50 mm)][4 inch (100 mm)][6 inch (150 mm)][8 inch (200 mm)][12 inch (300 mm)][16 inch (400 mm)][18 inch (450 mm)][20 inch (500 mm)][24 inch (600 mm)] unless otherwise indicated on Drawings.
b. Minimum Usable Load Depth: [1 inch (25 mm)][2 inch (50 mm)][4 inch (100 mm)][6 inch (150 mm)].
c. Straight Section Lengths: [10 ft (3.0 m)][12 ft (3.7 m)], except where shorter lengths are required to facilitate tray assembly.
d. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.

E. UL CYNW - Single-Rail Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atkore Cope**]
b. [**Cable Management Solutions, Inc.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**MonoSystems, Inc**]
e. [**MP Husky USA Cable Tray & Cable Bus**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Atkore Cope**]
b. [**Cable Management Solutions, Inc.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**MonoSystems, Inc**]
e. [**MP Husky USA Cable Tray & Cable Bus**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

a. Configuration: An extruded-aluminum assembly, consisting of a single longitudinal center rail with transverse rungs arranged symmetrically about the center rail complying with NEMA VE 1.
b. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
c. Radius-Fitting Rung Spacing: 9 inch (225 mm) at center of tray's width.
d. Support Point: Splice fittings must be hanger support point.
e. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
f. Unbalanced Loads: Maintain cable tray rungs within six degrees of horizontal under all loading conditions.
g. Splicing Assemblies: Bolted type using serrated flange locknuts.
h. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
i. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.

5. Materials: Aluminum alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
6. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].

    a. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Options:

    a. Width: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**] unless otherwise indicated on Drawings.
    b. Minimum Usable Load Depth: [**3 inch (75 mm)**][**4 inch (100 mm)**][**5 inch (125 mm)**][**6 inch (150 mm)**].
    c. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**], except where shorter lengths are required to facilitate tray assembly.
    d. Rung Spacing: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**] on center.
    e. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
    f. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

F. UL CYNW - Solid-Bottom Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Atkore Cope**]
    c. [**BASOR Electric**]
    d. [**Chalfant Manufacturing Company**]
    e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    f. [**MonoSystems, Inc**]
    g. [**MP Husky USA Cable Tray & Cable Bus**]
    h. [**Niedax Inc.**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Atkore Cope**]
    c. [**BASOR Electric**]
    d. [**Chalfant Manufacturing Company**]
    e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    f. [**MonoSystems, Inc**]
    g. [**MP Husky USA Cable Tray & Cable Bus**]
    h. [**Niedax Inc.**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. General Characteristics:

    a. Configuration: Two longitudinal side rails with a nonventilated continuous bottom.
    b. No portion of the continuous bottom must protrude below the bottom plane of side rails.
    c. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a **200 lb. (90 kg)** concentrated load, when tested in accordance with NEMA VE 1.
    d. Splicing Assemblies: Bolted type using serrated flange locknuts.
    e. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

    a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
    b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
    c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
    d. Finish:

        1) Mill galvanized before fabrication complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
        2) Electrogalvanized before fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
        3) Hot-dip galvanized after fabrication complying with ASTM A123/A123M, Class B2, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316**] hardware.
        4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

            a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
            b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
            c) Epoxy-Resin Topcoat: Cold-cured epoxy gloss, MPI# 77.

        5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
        6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
        7) <**Insert finish**>.

6. Materials and Finishes (Aluminum):

    a. Materials: Alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
    b. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].
    c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Materials and Finishes (Stainless Steel):

    a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**][**or**][**Type 316L**], ASTM F593 and ASTM F594.
    b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM

F593 and ASTM F594.

8. Options:

   a. Width: [6 inch (150 mm)][9 inch (225 mm)][12 inch (300 mm)][18 inch (450 mm)][24 inch (600 mm)][30 inch (750 mm)][36 inch (900 mm)] unless otherwise indicated on Drawings.
   b. Minimum Usable Load Depth: [3 inch (75 mm)][4 inch (100 mm)][5 inch (125 mm)][6 inch (150 mm)].
   c. Straight Section Lengths: [10 ft (3.0 m)][12 ft (3.7 m)][20 ft (6.0 m)][24 ft (7.4 m)], except where shorter lengths are required to facilitate tray assembly.
   d. Fitting Minimum Radius: [12 inch (300 mm)][24 inch (600 mm)][36 inch (900 mm)][48 inch (1200 mm)].
   e. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
   f. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

G. UL CYNW - Trough Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Cablofil; Legrand North America, LLC**]
   c. [**Chalfant Manufacturing Company**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**MonoSystems, Inc**]
   f. [**MP Husky USA Cable Tray & Cable Bus**]
   g. [**Niedax Inc.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Cablofil; Legrand North America, LLC**]
   c. [**Chalfant Manufacturing Company**]
   d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   e. [**MonoSystems, Inc**]
   f. [**MP Husky USA Cable Tray & Cable Bus**]
   g. [**Niedax Inc.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

   a. Splicing Assemblies: Bolted type using serrated flange locknuts.
   b. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
d. Finish:

1) Hot-dip galvanized after fabrication complying with ASTM A123/A123M, Class B2, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316**] hardware.
2) Hot-dip mill galvanized before fabrication complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
7) <**Insert finish**>.

6. Materials and Finishes (Aluminum):

a. Materials: Alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Materials and Finishes (Stainless Steel):

a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**][**or**][**Type 316L**], ASTM F593 and ASTM F594.
b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

8. Options:

a. Configuration:

1) A [**flat**][**corrugated**] bearing surface with a [**solid**][**ventilated**] bottom contained within two longitudinal side rails, with both edges welded to the side rails complying with NEMA VE 1.
2) Single, formed sheet with a [**solid**][**ventilated**] bottom, complying with NEMA VE 1.

b. Width: [6 inch (150 mm)][9 inch (225 mm)][12 inch (300 mm)][18 inch (450 mm)][24 inch (600 mm)][30 inch (750 mm)][36 inch (900 mm)] unless otherwise indicated on Drawings.
c. Minimum Usable Load Depth: [3 inch (75 mm)][4 inch (100 mm)][5 inch (125 mm)][6 inch (150 mm)].
d. Straight Section Lengths: [10 ft (3.0 m)][12 ft (3.6 m)][20 ft (6.0 m)][24 ft (7.4 m)], except where shorter lengths are required to facilitate tray assembly.
e. Fitting Minimum Radius: [12 inch (300 mm)][24 inch (600 mm)][36 inch (900 mm)][48 inch (1200 mm)].
f. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
g. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

H. UL CYNW - Channel Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Atkore Cope**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**MP Husky USA Cable Tray & Cable Bus**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Atkore Cope**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**MP Husky USA Cable Tray & Cable Bus**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

   a. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200 lb (90 kg) concentrated load, when tested in accordance with NEMA VE 1.
   b. Splicing Assemblies: Bolted type using serrated flange locknuts.
   c. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

5. Materials and Finishes (Steel):

   a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**][**ASTM A1008/A1008M, Grade 33, Type 2**].
   b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.

d. Finish:

1) Hot-dip galvanized after fabrication complying with ASTM A123/A123M, Class B2, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**][**Stainless steel, Type 316**] hardware.
2) Hot-dip mill galvanized before fabrication complying with ASTM A653/A653M, **G90 (Z275)**, with [**galvanized, ASTM B633**][**chromium-zinc plated, ASTM F1136**] hardware.
3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
4) [**Epoxy-resin**][**Powder-coat enamel**] paint, with [**chromium-zinc plated, ASTM F1136**][**stainless steel, Type 316, ASTM F593 and ASTM F594**] hardware.

a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.
7) <**Insert finish**>.

6. Materials and Finishes (Aluminum):

a. Materials: Alloy 6063-T6 in accordance with ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**][**or**][**Alloy 6061-T6**] in accordance with ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: [**Chromium-zinc-plated steel, ASTM F1136**][**Stainless steel, Type 316, ASTM F593 and ASTM F594**].
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

7. Materials and Finishes (Stainless Steel):

a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**][**or**][**Type 316L**], ASTM F593 and ASTM F594.
b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

8. Options:

a. Configuration: Single, formed sheet with a [**solid**][**ventilated**] bearing surface, complying with NEMA VE 1.
b. Width: [**3 inch (75 mm)**][**4 inch (100 mm)**][**6 inch (150 mm)**] unless otherwise indicated on Drawings.
c. Minimum Usable Load Depth: [**1-1/4 inch (30 mm)**][**2 inch (50 mm)**].
d. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**], except where shorter lengths are required to facilitate tray assembly.
e. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**][**36 inch (900 mm)**][**48 inch (1200 mm)**].
f. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.

g. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

2.2 NONMETALLIC CABLE TRAYS

A. Description: This product category covers nonmetallic, including fiberglass (fiberglass-reinforced plastic), cable trays and cable tray systems intended for field assembly and for use in accordance with Article 392 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN CYOV; including UL 568.

C. UL CYOV - Fiberglass Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Atkore Cope**]
d. [**Cablofil; Legrand North America, LLC**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Enduro Composites Inc.**]
g. [**MonoSystems, Inc**]
h. [**MP Husky USA Cable Tray & Cable Bus**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Atkore Cope**]
d. [**Cablofil; Legrand North America, LLC**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Enduro Composites Inc.**]
g. [**MonoSystems, Inc**]
h. [**MP Husky USA Cable Tray & Cable Bus**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

a. Configuration: Two longitudinal members with rounded edges and smooth surfaces, supporting a bearing surface, complying with NEMA FG 1.

b. Temperature Rating: Reduce the load rating of trays exposed to temperatures above **75 deg F (24 deg C)** in accordance with Table 4-3, "Working Loads," in NEMA FG 1.
c. Splicing Assemblies: Minimum four nuts and bolts per plate. Splice plates must be furnished with straight sections and fittings.
d. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
e. Fasteners: Fiberglass-encapsulated, ASTM F593 and ASTM F594 stainless steel, Type 316. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation must not be damaged when torqued to manufacturer's recommended value.

5. Options:

a. Materials: Straight section structural elements; side rails, rungs, and splice plates must be pultruded from glass-fiber-reinforced [**polyester**][**vinyl ester**] resin, complying with NEMA FG 1 and UL 568.
b. Width: [**6 inch (150 mm)**][**9 inch (225 mm)**][**12 inch (300 mm)**][**18 inch (450 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**][**36 inch (900 mm)**] unless otherwise indicated on Drawings.
c. Minimum Usable Load Depth: [**1 inch (25 mm)**][**2 inch (50 mm)**][**3 inch (75 mm)**][**5 inch (125 mm)**][**7 inch (175 mm)**] in accordance with NEMA FG 1.
d. Straight Section Lengths: [**10 ft (3.0 m)**][**20 ft (6.0 m)**].
e. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
f. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**].
g. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

D. UL CYOV - Fiberglass Channel Cable Tray :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Atkore Cope**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Enduro Composites Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Atkore Cope**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Enduro Composites Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. General Characteristics:

a. Temperature Rating: Reduce the load rating of trays exposed to temperatures above **75 deg F (24 deg C)** in accordance with Table 4-3, "Working Loads," in NEMA FG 1.
b. Splicing Assemblies: Minimum four nuts and bolts per plate. Splice plates must be furnished with straight sections and fittings.
c. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
d. Fasteners: Fiberglass-encapsulated, ASTM F593 and ASTM F594 stainless steel, Type 316. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation must not be damaged when torqued to manufacturer's recommended value.

5. Options:

a. Configuration: Two longitudinal members with rounded edges and smooth surfaces, supporting a [**solid**][**ventilated**] bearing surface, complying with NEMA FG 1.
b. Materials: Straight section structural elements; side rails, rungs, and splice plates must be pultruded from glass-fiber-reinforced [**polyester**][**vinyl ester**] resin, complying with NEMA FG 1 and UL 568.
c. Width: [**3 inch (75 mm)**][**4 inch (100 mm)**][**6 inch (150 mm)**] unless otherwise indicated on Drawings.
d. Minimum Usable Load Depth: [**1-1/4 inch (30 mm)**][**2 inch (50 mm)**].
e. Straight Section Lengths: [**10 ft (3.0 m)**][**12 ft (3.7 m)**], except where shorter lengths are required to facilitate tray assembly.
f. Class Designation: Comply with NEMA VE 1, [**Class 5AA**][**Class 5A**][**Class 8AA**][**Class 8A**][**Class 10AA**][**Class 10A**][**Class 12AA**][**Class 12A**][**Class 20AA**][**Class 20A**]<**Insert designation**>.
g. Fitting Minimum Radius: [**12 inch (300 mm)**][**24 inch (600 mm)**].
h. Covers: [**Solid**][**Louvered**][**Ventilated-hat**][**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. Factory Tests:

1. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

2. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate cable trays.
3. Factory Tests and Inspections: Perform the following tests and inspections on cable trays, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

    a. Test and inspect cable trays in accordance with [**NEMA FG 1**][**NEMA VE 1**].

4. Nonconforming Work:

    a. Equipment that does not pass tests and inspections will be considered defective.

5. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following for each cable tray system:

1. Cable Tray Fabrication Drawings, Diagrams, and Supporting Documents:

    a. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
    b. Include load calculations to show that dead and live loads do not exceed manufacturer's rating for tray and its support elements.
    c. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

        1) Vertical and horizontal offsets and transitions.
        2) Clearances for access above and to sides of cable trays.
        3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.

3.2 INSTALLATION OF CABLE TRAYS

A. Install cable tray and support systems in accordance with [**NEMA FG 1**][**NEMA VE 2**].

B. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.

F. Fasten cable tray supports to building structure[**and install seismic restraints**].

G. Design fasteners and supports to carry cable tray, cables, and a concentrated load of **200 lb (90 kg)**. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."[**Comply with seismic-restraint details in accordance with Section 260548.16 "Seismic Controls for Electrical Systems."**]

H. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with [**center support hangers**][**trapeze hangers**][**wall brackets**].

N. Support [**center support hangers**][**trapeze hangers**] for wire-basket trays with [**1/4 inch (6 mm)**][**3/8 inch (10 mm)**] diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed recommended dimensions. Space connectors and set gaps in accordance with applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers.

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V.

W. Install permanent covers[**and cover clamps**], if used, after installing cable.

X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.3 CABLE TRAY GROUNDING

A. Ground cable trays in accordance with NFPA 70 unless additional grounding is specified.

B. Cable trays with electrical power conductors must be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors must be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at **72 inch (1800 mm)** intervals. The grounding conductor must be sized in accordance with Article 250 and Article 392 of NFPA 70.

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized in accordance with Article 250 of NFPA 70.

3.4 INSTALLATION OF CABLES

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every **18 inch (450 mm)**.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure must be no more than **72 inch (1800 mm)**.

E. Tie mineral-insulated cables down every **36 inch (900 mm)** where required to provide a two-hour fire rating and every **72 inch (1800 mm)** elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.5 FABRICATION OF CONNECTION POINTS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays in accordance with requirements in NEMA VE 2 and NEMA FG 1.

3.6 INSTALLATION OF CABLE TRAY MARKINGS AND SIGNS

A. Trays Containing Cables Operating Over 600 V: Provide hazard markings in accordance with Section 392.18 of NFPA 70 and with NEMA Z535.4.

1. Legend: "DANGER - HIGH VOLTAGE - KEEP AWAY."

B. Ladder Cable Trays: Provide warning signs to prevent use as personnel ladder.

1. Lettering: [**1-1/2 inch (40 mm)**]<**Insert dimension**> high.
2. Legend: "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

3.7 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 Ω.

D. Nonconforming Work:

1. Cable tray will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.8 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and must remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 05 36 00

Task	Specification	Specification Description
26 05 36 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 39 00 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Underfloor raceway products.
2. Underfloor raceway fittings.
3. Maintenance material items.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. [**Section 013100 "Project Management and Coordination"**] specifies preinstallation conference procedures.
3. Section 033000 "Cast-in-Place Concrete" specifies installation of concrete surrounding underfloor raceways.
4. Section 034100 "Precast Structural Concrete" specifies precast concrete units used as cellular concrete floor raceways.
5. Section 053100 "Steel Decking" specifies rough-in of underfloor duct distribution system.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies installation of wiring for the Work specified in this Section.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies installation of grounding and bonding for the Work specified in this Section.
8. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies installation of cover plates for outlet, device, and junction boxes.
9. Section 260553 "Identification for Electrical Systems" specifies installation of labels and warning signs for the Work specified in this Section.
10. Section 262726 "Wiring Devices" specifies installation of receptacles and connectors.
11. Section 271513 "Communications Copper Horizontal Cabling" specifies installation of twisted pair jacks, outlets, assemblies, and cover plates.
12. Section 271523 "Communications Optical Fiber Horizontal Cabling" specifies installation of optical fiber jacks, outlets, assemblies, and cover plates.
13. Section 271533 "Communications Coaxial Horizontal Cabling" specifies installation of coaxial jacks, outlets, assemblies, and cover plates.

1.2 DEFINITIONS

A. Activation: Nomenclature used by some manufacturers for a service fitting.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at the Project site**][**by web conference**].

B. Preinstallation Coordination Meeting(s): For coordination of structural, electrical, and interior finishes Work for installation of underfloor raceways. Conduct meeting(s) [**at the Project site**][**as web conference**].

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect [**Construction Manager**][**and the Owner]** of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.
3. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents Detailing Fabrication and Assembly of Underfloor Raceways:

a. Include floor plans, elevations, sections, and details.
b. Identify components and accessories, such as expansion-joint assemblies, straight raceway lengths, preset and afterset inserts, and service fittings.
c. Detail preparation and installation methods and instructions.
d. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
e. Provide raceway fill charts for each duct size provided for each conductor size the duct is identified to accept. Provide separate charts for power and communication conductors and cables.
f. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements, including slab reinforcement, floor finish work, permanent partitions, expansion joints [**architectural module lines**][**and pretensioning or post-tensioning components**] .
g. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
h. Indicate thickening of slabs where required for adequate encasement of raceway components.
i. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
j. Revise locations from those indicated in the Contract Documents, as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
k. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.

l. Identify those cells of cellular floor deck that are to be connected and fitted for the following underfloor distribution:

1) Power.
2) Voice.
3) Data.
4) Signal.
5) Communications.

C. Samples for Verification: For each underfloor raceway product, in specified finish, including the following:

1. Service fittings and flush and recessed outlet and junction-box covers.
2. A section of each service raceway configuration, with specified preset insert and service fitting installed.
3. A junction box of each size and type for use with underfloor raceway.
4. A section of each header raceway configuration, complete with provisions for connection with service raceway.
5. A section of trench-type raceway, complete with cover and required trim.
6. A junction box of each size and type for use with trench-type raceway, complete with cover and trim.

D. Field QC Reports: For specified tests and inspections.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: For each type of specified product.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For underfloor raceways.

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:

a. Manufacturer's published instructions for locating preset inserts and for installing afterset inserts.
b. Dimensioned locations for all ducts, junction boxes, and preset inserts. Typical spacing designation must be accepted only for preset insert spacing along a continuous length of duct.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] .

2. Component Importance Factor (Ip): [**1.0**][**1.5**] .

3. Component Amplification Factor (ap): [**1.0**][**2.5**].

4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: [**120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces**].

2.2 UNDERFLOOR RACEWAY PRODUCTS

A. Flat-Top, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**MonoSystems, Inc**]
b. [**Square D; Schneider Electric USA**]
c. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

    a. Product Reference Standard(s): Article 390 of NFPA 70.
    b. Configuration: Steel, rectangular, flat-top, single-channel raceways with premanufactured inserts.
    c. Materials: One-piece, continuous weld, minimum **0.0598 inch (1.5 mm)** thick steel, with [**corrosion-resistant**][**galvanized**] coating inside and out after welding.
    d. Cross-Section Shape: Rectangular, with rounded corners.

    e. Number of Longitudinal Channels: [**Two**][**Three**][**Four**] , separated by steel wall(s).

    f. Number of Levels: [**One**][**Two**] .

    g. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks must provide a [**2 inch (50 mm)**] minimum bending radius for communication cables.

5. Service Raceways: Fitted with preset inserts.

    a. Nominal Multichannel Underfloor Raceway Dimensions:

        1) Depth: **1-3/8 inch (35 mm)**.
        2) Overall Width: [**6 inch (150 mm)**][**10 inch (250 mm)**][**15 inch (375 mm)**].
        3) Power Service Channel Width: [**3-1/2 inch (88 mm)**][**4-3/8 inch (110 mm)**].
        4) Communication Service Channel Width: [**3-1/2 inch (88 mm)**][**4 inch (100 mm)**][**6-1/2 inch (163 mm)**].

    b. Nominal Single-Channel Underfloor Raceway Dimensions:

        1) Depth: **1-1/2 inch (38 mm)**.
        2) Power Service Raceway Width: **3-1/4 inch (81 mm)**.
        3) Communication Service Raceway Width: [**3-1/4 inch (81 mm)**][**6 inch (150 mm)**] .

        4) Number of Single-Channel Raceways per Run: [**One**][**Two**][**Three**][**Four**][**Five**] unless otherwise indicated.

    c. Preset Inserts: [**Rectangular**][**Round**] .

        1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**] on center.

            a) Rectangular Insert Size: Rectangular dimensions as required to accommodate mounting and connection of flush- and surface-mounted, [**single-**][**and multiple-**] outlet service fittings or to connect to wiring extensions for feeding wall outlets for [**power**][**communications**][**power and**

communications].

b) Round Insert Size: [**2 inch (50 mm)**] in diameter.

2) Equip each insert with a disposable cover, and select insert height so cover is **1/8 inch (3 mm)** below surface of concrete.

3) Arrange insert for optional attachment of flush-, surface-, or wiring-extension service fitting to replace disposable cover. Arrange brackets, mountings, barriers, and floor access covers to support, isolate, and provide access to [**flush**][**surface**] outlet-mounting connector, jack, and receptacle devices.

6. Header Raceways: [**Single-**][**Multi**] channel, without preset inserts (blank raceway).

a. Nominal Raceway Dimensions:

1) Depth: [**Same as service raceways**][**2-1/2 inch (63 mm)**][**2-3/4 inch (69 mm)**][**3 inch (75 mm)**][**3-1/2 inch (88 mm)**] .

2) Power Header Raceway Width: [**3-1/2 inch (88 mm)**][**4-3/8 inch (110 mm)**].

3) Communication Header Raceway Width: [**3-1/2 inch (88 mm)**][**4 inch (100 mm)**][**6-1/2 inch (163 mm)**] .

b. Arrangement: [**In same plane as**][**Below**] service raceways.

c. Connections: Arranged to connect with service raceways at [**single**][**two**] -level junction boxes.

B. Flush, Flat-Top, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.

3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

a. Configuration: [**Single**][**multichannel**] underfloor raceways installed on floor slab with top of raceway flush with concrete topping added hereafter, and then covered with finish material.

b. Material: Steel.

c. Cross-Section Shape: Rectangular, [**single channel**][**and**][**multichannel, separated by steel wall(s)**] .

d. Listed and labeled for installation with top flush with concrete floor.

e. Number of Levels: One.

5. Service Raceways: Fitted with preset inserts.

    a. Number of Longitudinal Channels per Multichannel Raceway: [**Two**][**Three**] .

    b. Number of Single-Channel Raceways per Run: [**One**][**Two**][**Three**] unless otherwise indicated.
    c. Nominal Channel Dimensions: **3 inch (75 mm)** wide by **1-1/4 inch (31 mm)** deep.
    d. Preset Inserts: Threaded opening with removable steel plug that is flush with top of raceway when screwed in place.

        1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**] on center, full length of each service raceway.
        2) Arrangement: Stagger insert locations on parallel raceways or channels to accommodate placement of adjacent service fittings.
        3) Size: **1-5/8 inch (41 mm)** diameter.

6. Trench Duct Crossunder: Fitting attached to underside of trench duct.

    a. Nominal Channel Dimensions: Same as service raceways.
    b. Arrangement: Offset by depth of trench duct.
    c. Connections: Arranged to connect trench duct to flush duct through factory-cut, grommeted openings.

7. Header Raceways: Raceways same as service raceways, except without preset inserts (blank raceway).

    a. Nominal Channel Dimensions: Same as service raceways.
    b. Arrangement: In same plane as service raceways.
    c. Connections: Arranged to connect with service raceways at junction boxes.

C. Cellular Metal, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ASC Steel Deck; ASC Profiles, LLC**]
    b. [**Dennis Filges Company, Inc**]
    c. [**Epic Metals Corporation**]
    d. [**HH Robertson**]
    e. [**United Steel Deck, Inc.**]
    f. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

a. Configuration: Multichannel, cellular, underfloor service raceways installed on floor slab with top of raceway flush concrete topping added hereafter, and then covered with finish material.
b. Material:

1) Galvanized-steel sheet, ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)** minimum, [**G60 (Z180)**][**G90 (Z275)**] zinc coating.
2) Galvanized- and shop-primed steel sheet, ASTM A653/A653M, Structural Steel (SS), Grade **33 (230)**, **G60 (Z180)** zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard [**gray**][**white**] baked-on, rust-inhibitive primer.

c. Number of Longitudinal Cells: Three, separated by steel walls.
d. Nominal Dimensions of Cells:

1) Overall Depth: **1-1/4 inch (31 mm)** unless otherwise indicated.
2) Cross-Sectional Area of Cells: Power cells: **5-1/2 sq. inch (34.4 sq. cm)**; communication system cells: **16 sq. inch (100 sq. cm)**.

e. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks must provide a [**2 inch (50 mm)**] minimum bending radius for communication cables.

5. Service Raceways: Fitted with preset inserts.

a. Preset Inserts: Rectangular-shaped metal housing assemblies arranged to provide electrical outlet access to each cell of each raceway designated for service raceway use. Inserts must be provided throughout the entire length of each such raceway.

1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**] on center.
2) Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-outlet service fitting.
3) Include mounting and connecting provisions for a surface, single- or multiple-outlet service fitting.
4) Include connecting provisions for a wiring-extension service fitting to feed wall outlets.
5) Equip each insert with a disposable cover plate arranged for installation with top **1/8 inch (3 mm)** below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable top.

6. Header Assembly: A junction box and raceway arrangement positioned to feed wires and cables to service raceways.

a. Three-compartment junction box connecting blank, [**multicell cellular**][**flat-top, multichannel**] header raceway (no inserts) with cellular service raceways at right angles to header raceway.
b. Cellular header raceway must be made of the same material and have the same nominal dimensions as service raceways.
c. Provide capability for service raceways to be run in both perpendicular directions at the intersection with header raceway.

D. Trench-Type, Steel Underfloor Raceways :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Dennis Filges Company, Inc**]
b. [**HH Robertson**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Square D; Schneider Electric USA**]
e. [**Walker Systems, Inc.**]

2. Source Limitations: Obtain underfloor raceway components for each system from single source from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Underfloor Raceways: UL Solutions product category UL CCN RKCZ, including UL 884.

4. Standard Features:

   a. Configuration: Trench-type raceways used as header or feeder raceways to serve service raceways.
   b. Trench: Steel, shop or factory welded and fabricated to indicated sizes. Include the following features:

      1) Slab Depth Adjustment: Minimum of minus **1/8 inch (3 mm)** to plus **5/8 inch (17 mm)** before and during concrete placement.
      2) Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.
      3) Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
      4) Trim Strip: Select to accommodate floor finish material.
      5) Partitions: Arranged to separate channels and isolate wiring of different systems.

      6) Grommeted openings in active floor cells or service raceways.
      7) Manufacturer's standard corrosion-resistant finish, applied after fabrication.

   c. Cover Plates: Removable, steel plates, **1/4 inch (6 mm)** thick, each weighing **60 lb. (27 kg)** or less with full gasket attached to side units. Fabricate intermediate supports to limit unsupported spans to [**15 inch (375 mm)**] or less. Fabricate covers with appropriate depth recess to receive indicated floor finish.

2.3 UNDERFLOOR RACEWAY FITTINGS

A. Electrical Connection Components for Cellular Steel Floor Decks:

1. Source Limitations for Electrified Cellular Steel Floor-Deck Components: Obtain electrical components, such as preset inserts, afterset inserts, service fittings, header ducts, and trench header ducts, from cellular steel floor-deck manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Preset Inserts: Rectangular metal-housing assemblies.

1) Spacing: [**12 inch (300 mm)**][**24 inch (600 mm)**][**30 inch (750 mm)**] on center.
2) Size: As required to provide electrical outlet access to each cell of each group of three cells that is designated for electrical service raceway use.
3) Equip each insert with a disposable cover arranged for installation with top **1/8 inch (3 mm)** below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable cover.

4) Include housing and connecting provisions for a [**flush or recessed**][**surface**] service fitting, [**single**][**double**][**triple**] outlet.
5) Include connecting provisions for a wiring-extension service fitting to feed wall outlets.

B. Electrical Connection Components for Cellular Concrete Floor Decks:

1. Source Limitations for Electrified Cellular Concrete Floor-Deck Components: Obtain electrical components, such as preset inserts, afterset inserts, service fittings, header ducts, and trench header ducts, from cellular concrete floor-deck manufacturer or from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Afterset Inserts: Round metal-nipple assembly with internal and external threading, arranged to screw into plug driven into **1-7/8 inch (47 mm)** hole drilled through floor fill, where present, and deck-cell wall into floor raceway cell.

1) Inserts must be compatible with floor-mounting service fittings.
2) Inserts must provide wiring path from cell to [**power**][**communication**][**power and communication**]
[**wall**][**and**][**ceiling**] outlets.
3) Inserts must provide wiring path from cell to header raceway.

C. Underfloor Raceway Service Fittings/Activations:

1. Source Limitations: Obtain underfloor raceway service fittings and hardware for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Exposed Parts Finish: [**Brass**][**Brushed aluminum**].

c. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.

1) Connector, Jack, and Receptacle Devices: Single modular type.
2) Power Receptacle Outlet: Suitable for 20 A, 120 V device.

d. Flush System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.

1) System Type: [**Single**][**multiple**] .
2) Connector, Jack, and Receptacle Devices: Modular type.
3) Power Receptacle Rating: 20 A, 120 V unless otherwise indicated.

4) Recess-Mounted Service Fitting: Modular fittings compatible with preset inserts. Include device plates for indicated systems and provisions for receptacles, jacks, and connectors. Include hinged flush covers with recessed depth to match thickness of floor finish material. Provide for internally mounted receptacle- and communication-jack and connector assemblies.

e. Surface-Mounted Service Fitting: Modular pedestal type, with locking attachment matched to insert floor opening.

1) Power-outlet, double-faced, surface-mounted unit for duplex receptacle on both sides.
2) Power-outlet, single-faced, surface-mounted unit for duplex receptacle on one side.
3) Communication-outlet, double-faced, surface-mounted unit.

a) Include bushed openings on both sides; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
b) Include provisions for modular dual fiber-optic connector assembly on both sides.
c) Include provisions for modular dual jack-connector assembly, rated for [**Category 5**][**Category 5e**][**Category 6**] on both sides.

4) Communication-outlet, single-faced, surface-mounted unit with bushed opening on one side; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
5) Combination surface-mounted unit for duplex receptacle on one side and with communication cable connection provision on opposite side.

a) Include bushed opening; **1 inch (25 mm)** minimum diameter; insulated with nonconducting material.
b) Include provisions for modular dual fiber-optic connector assembly.
c) Include provisions for modular dual jack-connector assembly, rated for

[**Category 5**][**Category 5e**][**Category 6**] .

6) Flush-Mounted Service Fittings: Modular fittings compatible with preset inserts and must include covers, provisions for receptacles jacks and connector assemblies and wiring extensions to wall-mounted outlets, and associated device plates for indicated systems. Include flush covers, recessed to suit floor finish material.

7) Wiring-Extension Service Fittings: Arrangement of brackets and mountings to support and provide access to wiring or cabling of a cell, and to connect the cable or raceway that extends the system to an individual wall outlet. Provide for connection of [**ERMC**][**FMC**][**ENT**][**Type MC cable**] for power extensions, and [**ERMC**][**FMC**][**ENT**][**optical fiber/communication cable raceway**] for communication system extensions.

D. Underfloor Raceway Adapter Fittings:

1. Source Limitations: Obtain underfloor raceway adapter fittings for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Description: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.
c. Compatible with raceway and outlet system and must be listed for use with raceway systems and components delivered.

E. Underfloor Raceway Supports and Hardware:

1. Source Limitations: Obtain underfloor raceway supports and hardware components for each system from single source from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Underfloor Raceway Fittings: UL Solutions product category UL CCN RKQX, including UL 884.

3. Standard Features:

a. Product Reference Standard(s): Article 390 of NFPA 70.
b. Supports and hardware must be compatible with raceway and outlet system and must be listed for use with raceway systems and components delivered.
c. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.

F. Underfloor Raceway Junction Boxes:

1. Configuration: Raceway manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:

a. Mounting brackets.
b. Escutcheons and holders to accommodate surrounding floor covering.
c. Means for leveling and height adjustment more than **3/8 inch (10 mm)** before and after concrete is placed.
d. Boxes must withstand a minimum [**300 lb (136 kg)**] concentrated load. Internal supports must be provided as needed to meet this requirement.
e. All boxes must provide **2 inch (50 mm)** minimum bend radius for data and communication cables.
f. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.

g. Covers must have appropriate depth recess to receive specific floor finish material.
h. Partitions to separate wiring of different systems.

2.4 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to the Owner spare parts, for repairing underfloor raceway, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Afterset Inserts:

a. Furnish quantity equal to [**10**] percent of service fittings installed, but no fewer than units.
b. Furnish quantity equal to [**5**] percent of each type of preset insert installed, but no fewer than units.

2. Service Fittings: Furnish [**three**] of each type of service fitting indicated for each **100 ft (30 m)** of distribution raceway or active-floor-cell length.
3. Outlet Blanking Covers: Furnish quantity equal to [**10**] percent of each type of floor opening installed for outlets.

B. Special Tools: Furnish to the Owner proprietary or special equipment required to operate, maintain, repair, adjust, or implement future changes to underfloor raceway, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Electronic Instruments: Furnish [**one**] electronic instrument(s) and accessories, in accordance with underfloor raceway manufacturer's published instructions for detecting, locating, and uncovering preset inserts in metal raceway under floor covering and up to **3/8 inch (10 mm)** of concrete fill.
2. Electric Drill: Furnish [**one**] variable-speed electric drill(s), **1/2 inch (13 mm)** capacity.

3. Hole Saw: Furnish [**one**] diamond bit hole saw(s), for dry concrete, [**2 inch (50 mm)**] size.
4. Afterset Insert Installation Tool: Furnish [**one**] installation tool(s) selected in accordance with manufacturer's published instructions for installing afterset inserts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Communications Work: BICSI N1.
8. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
12. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
13. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for underfloor raceway products and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

    d. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.

        1) Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
        2) Install markers flush at screed line before pouring slab or placing fill. Extend marker with grommeted screw when floor covering is placed. Do not extend through carpet.
        3) Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications.
        4) Use another distinctive screw head to identify third system, such as special-purpose wiring.

2. Grounding and Bonding:

a. Equipment Grounding Conductors: Provide and route insulated equipment grounding conductors with other feeder or branch circuit conductors. Bond equipment grounding conductor to underfloor raceway products using provided hardware in accordance with manufacturer's published instructions.
b. Equipment Bonding Conductors: Provide equipment bonding straps or jumpers where additional bonding is indicated on the Drawings between underfloor raceway products and adjacent metallic equipment, enclosures, piping, or building structure. Route bonding conductors along shortest and straightest paths possible unless otherwise indicated or required by NFPA 70. Avoid obstructing access panels or placing conductors where they may be subjected to strain, impact, or damage.

3. Coordinate installation of new underfloor raceway products with existing conditions.
4. Coordinate installation of underfloor raceway products with installation of concrete.

3.3 INSTALLATION OF UNDERFLOOR RACEWAY PRODUCTS

A. Install underfloor raceway products aligned and leveled and, unless otherwise indicated, parallel or perpendicular to floor supports.

B. Maintain arrangement of conductor services throughout the raceway system.

C. Install a concrete mud slab for support of cellular metal, flush duct, or trench duct raceway. Construct mud slab with wire mesh in the top **1 inch (25 mm)** of concrete.

D. Install a vapor barrier between the cellular metal raceway and a substrate in contact with earth.

E. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Fasten supports securely at ends and at intervals not to exceed **60 inch (1500 mm)**, to prevent movement during concrete pour.

F. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.

G. Underfloor Raceway Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of the Work.

H. Install preset inserts per manufacturer's instructions.

I. Adjust supports to maintain a **1/8 to 3/8 inch (3.0 to 10 mm)** finished concrete cover over preset inserts.

J. Remove burrs, sharp edges, dents, and mechanical defects.

K. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.

L. Install expansion fittings with suitable bonding jumper where raceways cross building expansion joints.

M. Ground and bond underfloor raceway components to create a continuous bonding path.

N. Seal raceways, cells, junction boxes, and inserts to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill. Tape joints or seal with compound, in accordance with underfloor raceway manufacturer's published instructions.

O. Install concrete surrounding underfloor raceways.

P. Afterset Inserts: Cut, hole saw, and drill slab and raceways to allow for installation at locations indicated on plans.

Q. Wiring must comply with NFPA 70 requirements for wet locations.

1. Install wiring from outlet insert toward junction boxes, then to termination at panel.
2. Splices: All splices and taps must be made in junction boxes. No splices or taps must be made in raceways or outlet inserts.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections, including Grounding:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field QC tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**], as directed by the Owner.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform visual inspection of interior of each [**junction box**][**section of trench raceway**] to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
3. Prior to and after concrete pour, perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.

    a. Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 Ω.
    b. Comply with NETA Acceptance Testing Specification about safety, suitability of test equipment, test instrument calibration, and test report and records.

D. Nonconforming Work:

1. Underfloor raceway products will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field QC Reports: Collect, assemble, and submit test and inspection reports.

3.5 CLEANING

A. Clean and swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

3.6 PROTECTION

A. Protect underfloor raceway products from damage. Do not use the installed duct system as working platforms or walkways. Do not allow equipment or heavy traffic over duct during construction period, without first installing ramps over the duct. Ramps must be designed so that imposed loads are not transferred to the duct. Components of the system that are damaged during construction must be replaced.

END OF SECTION 26 05 39 00

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Task	Specification	Specification Description
26 05 39 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 43 00 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EPEC raceways and fittings.
2. Type ERMC-SS raceways, elbows, couplings, and nipples.
3. Type ERMC-S raceways, elbows, couplings, and nipples.
4. Type IMC raceways.
5. Type PVC raceways and fittings.
6. Type RTRC-BG raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Electrically conductive corrosion-resistant compounds for threaded conduit.
9. Solvent cements.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> specifies preinstallation conference procedures.
4. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
5. Section 260553 "Identification for Electrical Systems" specifies underground-line warning tape and concrete cable routing markers (warning planks).

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For underground ducts and raceways. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For concrete and steel used in precast concrete [**manholes**][**and**][**handholes**], also include product certificates as required by ASTM C858.

B. Sustainable Design Product Data:

1. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Electric Utility Duct Banks and Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Indicate locations of private property boundaries and utility easements.
c. Include information required for approval by electric utility and for obtaining public space utility work permits.

2. Precast or Factory-Fabricated Concrete Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include [**ladder**][**step**] details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
h. Include joint details.

3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

B. Field Reports:

1. Factory Test Reports: For handholes and boxes.
2. Manufacturer's field reports for field quality-control support.

PART 2 - PRODUCTS

2.1 TYPE EPEC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651A and UL CCN EAZX.

B. Schedule 40 Electrical HDPE Underground Conduit (EPEC-40):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Dimensional Specifications: Schedule 40.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

C. Schedule 80 Electrical HDPE Underground Conduit (EPEC-80):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Blue Diamond Industries, LLC**]
b. [**JM Eagle**]
c. [**Petroflex North America**]
d. [**Prysmian Cables and Systems; Prysmian Group North America**]
e. [**Southwire Company, LLC**]
f. <**Insert manufacturer's name**>

2. Dimensional Specifications: Schedule 80.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

D. Type A Electrical HDPE Underground Conduit (EPEC-A):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type A.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

E. Type B Electrical HDPE Underground Conduit (EPEC-B):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type B.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.2 TYPE ERMC-SS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6A and UL CCN DYWV.

B. Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Patriot Aluminum Products, LLC**]
f. <**Insert manufacturer's name**>

2. Material: Stainless steel.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
b. Colors: As indicated on Drawings.

2.3 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Allied Tube & Conduit; Atkore International**]
b. [**Calconduit; Atkore International**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Patriot Aluminum Products, LLC**]
f. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
g. [**Topaz Lighting & Electric**]
h. [**Western Tube; Zekelman Industries**]
i. [**Wheatland Tube; Zekelman Industries**]
j. <**Insert manufacturer's name**>

2. Exterior Coating: Zinc.
3. Options:

a. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
b. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
c. Colors: As indicated on Drawings.

C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Bluesteel Services LLC**]
c. [**Calbond; Atkore International**]
d. [**KorKap; Robroy Industries**]
e. [**Perma-Cote; Robroy Industries**]
f. [**Plasti-Bond; Robroy Industries**]
g. <**Insert manufacturer's name**>

2. Additional Characteristics:
3. Fittings for PVC-Coated Conduit:

a. Minimum coating thickness of **0.040 inch**, with overlapping sleeves protecting threaded joints.
b. Conduit bodies must be Form 8 with effective seal and positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig

(positive) and 25 inch Hg (vacuum) for 72 hours must be available. Conduit bodies must be supplied with plastic-encapsulated stainless steel cover screws.

c. Form **2 inch** long or one pipe diameter long, whichever is less, PVC sleeve at openings of female fittings, except unions. Inside sleeve diameter must be matched to outside diameter of metal conduit.
d. PVC coating on outside of conduit couplings must be protected from tool damage during installation.
e. Female threads on fittings and couplings must be protected by urethane coating.
f. Fittings must be from same manufacturer as conduit.
g. Beam clamps and U bolts must be formed and sized to fit outside diameter of coated conduit. Plastic-encapsulated nuts must cover exposed portions of threads.

4. Options:

a. Exterior Coating: PVC complying with NEMA RN 1[**and marked ETL Verified PVC-001**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
d. Colors: As indicated on Drawings.
e. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
f. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.4 TYPE IMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1242 and UL CCN DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Allied Tube & Conduit; Atkore International**]
c. [**Calconduit; Atkore International**]
d. [**Republic Conduit; Nucor Corporation, Nucor Tubular Products**]
e. [**Topaz Lighting & Electric**]
f. [**Western Tube; Zekelman Industries**]
g. [**Wheatland Tube; Zekelman Industries**]
h. <**Insert manufacturer's name**>

2. Options:

a. Exterior Coating: [**Zinc**][**Alternative corrosion-resistant coating**].
b. Interior Coating: [**Zinc with organic top coating**][**Zinc**][**Organic coating**].
c. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
d. Colors: As indicated on Drawings.

2.5 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**NAPCO; Westlake Chemical Corp.**]
e. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
f. [**Topaz Lighting & Electric**]
g. <**Insert manufacturer's name**>

2. Dimensional Specifications: Schedule 40.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
b. Markings: [**For use with maximum 90 deg C wire.**][**For directional boring applications.**]

C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Calconduit; Atkore International**]
c. [**JM Eagle**]
d. [**Opti-Com Manufacturing Network, Inc (OMNI)**]
e. [**Topaz Lighting & Electric**]
f. <**Insert manufacturer's name**>

2. Dimensional Specifications: Schedule 80.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].
b. Markings: [**For use with maximum 90 deg C wire.**][**For directional boring applications.**]

D. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Southern Pipe, Inc.**]
b. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type A.
3. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

E. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JM Eagle**]
b. [**Southern Pipe, Inc.**]
c. <**Insert manufacturer's name**>

2. Dimensional Specifications: Type EB.
3. Options:

a. Minimum Trade Size: [**Metric designator 53 (trade size 2)**][**Metric designator 78 (trade size 3)**][**Metric designator 103 (trade size 4)**].

2.6 TYPE RTRC-BG RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 2420 and UL CCN DZKT, for Type BG.

B. Low-Halogen, Belowground Reinforced Thermosetting Resin Conduit (RTRC-BG) and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Options:

a. Minimum Trade Size: [**Metric designator 16 (trade size 1/2)**][**Metric designator 21 (trade size 3/4)**].

2.7 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Metallic Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
d. [**Konkore Fittings; Atkore International**]
e. [**O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group**]
f. [**Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway**]
g. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Southwire Company, LLC**]
i. [**Topaz Lighting & Electric**]
j. <**Insert manufacturer's name**>

2. General Characteristics: UL 514B and UL CCN DWTT.
3. Options:

a. Material: [**Steel**][**Die cast**].
b. Coupling Method: [**Compression coupling**][**Raintight compression coupling with distinctive color gland nut**][**Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable**].
c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.8 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. <**Insert manufacturer's name**>

2.9 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.
3. Sustainability Characteristics:

a. VOC Content: [**510**][**490**]<**Insert value**> g/L or less for [**PVC**][**CPVC**] conduit and fittings.
b. Low-Emitting Material Requirements: As recommended by solvent and adhesive manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Solvent Cements for Type PVC Raceways and Fittings:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2.10 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

2.11 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

B. Cast-in-Place Concrete Manholes:

1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.

2. Additional Criteria: Comply with Section 033000 "Cast-in-Place Concrete."

2.12 SOURCE QUALITY CONTROL

A. Factory Tests for Handholes and Boxes:

1. Testing Administrant: [**Owner will engage**][**Engage**] qualified structural testing agency to evaluate handholes and boxes.

a. Tests of materials must be performed by independent testing agency.
b. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.

2. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified testing laboratory's**] certification of system compliance.

a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

3. Nonconforming Work:

a. Equipment that does not pass tests and inspections will be considered defective.

4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Steel raceway, bends, and fittings in [**single duct run or duct bank**][**on Project**] must be of same type.
3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.

4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
5. Install expansion fitting near center of straight line duct with calculated expansion of more than **3/4 inch**.
6. Curves and Bends:

    a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of [**48 inch**][**12.5 ft**][**25 ft**], both horizontally and vertically, at other locations unless otherwise indicated.
    b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of [**48 inch**][**12.5 ft**][**25 ft**]. Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
    c. Duct must have maximum of 180 degrees of bends between pull points.

7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete for minimum of **12 inch** on each side of coupling.

    a. Install insulated grounding bushings on steel raceway terminations that are less than **12 inch** below grade or floor level and do not terminate in hubs.

8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above **104 deg F**. Where environmental temperatures are calculated to rise above **104 deg F**, and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of **104 deg F**.
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately **10 inch** o.c. for **5 inch** duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to end-bell spacing **10 ft** from end bell, without reducing duct slope and without forming trap in line.
    b. Grout end bells into structure walls from both sides to provide watertight entrances.

10. Duct Terminators for Entrances to Cast-in-Place Manholes and Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately **6 inch** o.c. for **4 inch** duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to terminator spacing **10 ft** from terminator, without reducing duct line slope and without forming trap in line.

11. Building Wall Penetrations: Make transition from underground duct to steel raceway at least **10 ft** outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
12. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

    a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete for minimum of **12 inch** on each side of coupling.

13. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least **15 psig** hydrostatic pressure.
14. Pulling Cord: Install **200 lbf** test nylon cord in empty ducts.
15. Concrete-Encased Ducts and Duct Bank:

    a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes **6 inch** or less in nominal diameter.
    b. Width: Excavate trench [**3 inch**][**12 inch**] wider than duct on each side.
    c. Depth: Install so top of duct envelope is at least **24 inch** below finished grade in areas not subject to deliberate traffic, and at least **30 inch** below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
    d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
    e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than [**four**][**five**] spacers per **20 ft** of duct. Place spacers within **24 inch** of duct ends. Stagger spacers approximately **6 inch** between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
    f. Minimum Space between Ducts: **3 inch** between edge of duct and exterior envelope wall, **2 inch** between ducts for like services, and **4 inch** between power and communications ducts.
    g. Elbows:

        1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
        2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of equipment base.

        1) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inchabove**] finished floor and minimum **3 inch** from conduit side to edge of slab.

    i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inchabove**] finished floor and no less than **3 inch** from conduit side to edge of slab.

    j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
    k. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
    l. Concrete Cover: Install minimum of **3 inch** of concrete cover between edge of duct to exterior envelope wall, **2 inch** between duct of like services, and **4 inch** between power and communications ducts.
    m. Place minimum **6 inch** of engineered fill above concrete encasement of duct.
    n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
2) If more than one pour is necessary, terminate each pour in vertical plane and install **3/4 inch** reinforcing-rod dowels extending minimum of **18 inch** into concrete on both sides of joint near corners of envelope.

o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

16. Direct-Buried Duct and Duct Bank:

a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than **6 inch** in nominal diameter.
b. Width: Excavate trench [**3 inch**][**12 inch**] wider than duct on each side.
c. Depth: Install top of duct at least **36 inch** below finished grade unless otherwise indicated.
d. Set elevation of top of duct bank below frost line.
e. Place minimum **3 inch** of sand as bed for duct. Place sand to minimum of **6 inch** above top level of duct.
f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than [**four**][**five**] spacers per **20 ft** of duct. Place spacers within **24 inch** of duct ends. Stagger spacers approximately **6 inch** between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
h. Install duct with minimum of **3 inch** between ducts for like services and **6 inch** between power and communications duct.
i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
j. Install manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct.

1) Couple RNC duct to steel raceway with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete.
2) Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of base. Install insulated grounding bushings on terminations at equipment.

a) Stub-ups must [**terminate in coupling installed flush with**][**be minimum 4 inch above**] finished base and minimum **3 inch** from conduit side to edge of base.

3) Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally on exterior of wall minimum of **60 inch** from edge of wall. Install insulated grounding bushings on terminations at equipment.
4) Stub-ups through interior floors must [**terminate in coupling installed flush**

with][**be minimum 4 inch above**] finished floor and no less than **3 inch** from conduit side to edge of equipment pad or floor slab.

k. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to **4 inch** over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

17. Warning Planks: Bury warning planks approximately **12 inch** above direct-buried duct, placing them **36 inch** o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each **12 inch** increment of duct-bank width over nominal **18 inch**. Space additional planks **12 inch** apart, horizontally across width of ducts.
18. Underground-Line Warning Tape: Bury [**nonconducting**][**conducting**] underground line specified in Section 260553 "Identification for Electrical Systems" no less than **12 inch** above concrete-encased duct and duct banks[**and approximately 12 inch below grade**]. Align tape parallel to and within **3 inch** of centerline of duct bank. Provide additional warning tape for each **12 inch** increment of duct-bank width over nominal **18 inch**. Space additional tapes **12 inch** apart, horizontally across width of ducts.
19. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.2 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Cast-in-Place Manholes:

a. Finish interior surfaces with smooth-troweled finish.
b. Knockouts for Future Duct Connections: Form and pour concrete knockout panels **1-1/2 to 2 inch** thick, arranged as indicated.
c. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

2. Precast Concrete Handholes and Manholes:

a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from **1 inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3. Elevations:

a. Manhole Roof: Install with rooftop at least **15 inch** below finished grade.
b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames **1 inch** above finished grade.
c. Install handholes with bottom below frost line, <**Insert depth of frost line below grade at Project site**> below grade.
d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
e. Where indicated, cast handhole cover frame integrally with handhole structure.

4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.

a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
b. Install chimney, constructed of [**precast concrete**][**cast-iron**] collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.

6. Waterproofing: Apply waterproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Waterproofing materials and installation are specified in [**Section 071353 "Elastomeric Sheet Waterproofing"**][**Section 071354 "Thermoplastic Sheet Waterproofing"**]<**Insert waterproofing Section**>. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
7. Dampproofing: Apply dampproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, [**and**]cable arms, [**and insulators,**]as required for installation and support of cables and conductors and as indicated.
9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than **3-7/8 inch** for manholes and **2 inch** for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
11. Ground manholes, handholes, and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing

conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.3 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:

1. <**Insert reference standard**> for <**Insert reason**>.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from **1/2 inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
4. Install handholes and boxes with bottom below frost line, <**Insert depth of frost line below grade at Project site**> below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in [**asphalt paving**][**and**]<**Insert material**> and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on [**compacted earth**]<**Insert material**>.

a. Concrete: **3000 psi**, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
b. Dimensions: [**10 inch wide by 12 inch deep**]<**Insert dimensions**>.

8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing**

related Work>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum **12 inch** long mandrel equal to duct size minus **1/4 inch**. If obstructions are indicated, remove obstructions and retest.
3. Test manhole[**and handhole**] grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

D. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

END OF SECTION 26 05 43 00

SECTION 26 05 43 00A - OVERHEAD MEDIUM-VOLTAGE WIRING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Conductors, connectors, and splices.
2. Wood poles.
3. Concrete poles.
4. Crossarms.
5. Guys and anchors.
6. Hardware and accessories.
7. Surge arresters.
8. Cutouts, switches, and fuses.
9. Pole-mounted distribution transformers.
10. Primary metering products.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.

1. Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).
2. Initial Unloaded Sag: The sag of a conductor before the application of an external load.

B. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 V or less.

C. Service: Set of insulated conductors extending from a pole to the metering point or service entrance connection at the location of utilization of electricity.

1.3 COORDINATION

A. Coordinate with utility supplying electricity to lines specified in this Section, and make [**final connections**][**arrangements for final connections by utility**].

B. Coordinate with those responsible for [**voice**][**data**][**video**]<**Insert services involved**> systems that will have cables supported by poles installed in accordance with this Section.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Conductors, connectors, and splices.
2. Wood poles.
3. Concrete poles.
4. Crossarms.
5. Guys and anchors.
6. Hardware and accessories.
7. Surge arresters.
8. Cutouts, switches, and fuses.
9. Pole-mounted distribution transformers.
10. Primary metering products.

B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory Test Reports:

a. Wood poles.
b. Concrete poles.
c. Crossarms.
d. Cutouts, switches, and fuses.
e. Pole-mounted distribution transformers.
f. Primary metering products.

2. Manufacturer's field reports for field quality-control support.

1.6 CLOSEOUT SUBMITTALS

A. Survey records for locations of pole, anchors, and other features for inclusion in Project Record Documents.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Fuses: [**One**]<**Insert number**> additional spare fuse(s) or fuse element(s) for each furnished fuse or fuse element.
2. Padlocks: [**One**]<**Insert number**> for every [**three**]<**Insert number**> installed, but no fewer than [**three**]<**Insert number**>.
3. Insulators: [**One**]<**Insert number**> for every 10 of each type, but no fewer than [**three**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to overhead medium-voltage wiring, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. [**Two**]<**Insert number**> sets of special-purpose tools required for maintenance of cutouts, switches, and reclosers, complete with toolbox.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.

C. Comply with [**IEEE C2**][**CPUC General Order 95**], except where stricter requirements are indicated or where local requirements that are stricter apply.

D. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for [**heavy**][**medium**][**light**] line loading unless otherwise indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Wood Pole Storage and Handling: Comply with ATIS O5.1. Do not use pointed handling tools capable of producing indentations greater than **1 inch (25 mm)**.

PART 2 - PRODUCTS

2.1 CONDUCTORS, CONNECTORS, AND SPLICES

A. Conductor Type AAC: [**Bare**][**and covered**], all-aluminum, Alloy 1350-H19, complying with ASTM B230/B230M and ASTM B231/B231M.

B. Conductor Type AAAC: [**Bare**][**and covered**], all-aluminum-alloy, Alloy 6201-T81, complying with ASTM B398/B398M and ASTM B399/B399M.

C. Conductor Type ACSR: [**Bare**][**and covered**], aluminum conductor, steel reinforced, complying with ASTM B232/B232M.

D. Conductor Type CU: [**Bare**][**and covered**], hard-drawn copper, complying with ASTM B1 and ASTM B8.

E. Conductor Covering: UV resistant, complying with ICEA-S-70-547. [**HDPE**][**or**][**XLP**], [**150 mil (3.81 mm)**]<**Insert value**> thick.

F. Self-Supported, Multiconductor, Insulated Medium-Voltage Wiring: Factory-assembled, messenger-supported type, listed under UL 1072 as sunlight-resistant Type MV cable for cable tray use.

1. Conductors: [**Aluminum, Alloy 1350, complying with ASTM B230/B230M and ASTM**

B231/B231M][**Hard-drawn copper, complying with ASTM B1 and ASTM B8**]; stranded for 2 AWG and larger.

2. Conductor Insulation: [**XLP, complying with NEMA WC 70/ICEA S-95-658**][**EPR, complying with NEMA WC 70/ICEA S-95-658**]<**Insert insulation**>.
3. Insulation Level: [**100**][**133**]<**Insert number**> percent of rated circuit line-to-line voltage.
4. Conductor Shield: Extruded, nonconducting, thermoset material, complying with NEMA WC 70/ICEA S-95-658; **18 mil (460 µm)** minimum thickness.
5. Insulation Shield: Include the following two components:

    a. Nonmetallic conducting, material complying with NEMA WC 70/ICEA S-95-658 and UL 1072, extruded over, and free stripping from the insulation.
    b. Metallic Tape Shield: Bare copper, **5 mil (127 µm)** minimum thickness, helically applied with a 15 percent minimum overlap.

6. Conductor Jacket: Extruded, chlorosulfonated-polyethylene-based material, complying with NEMA WC 70/ICEA S-95-658.
7. Messenger: [**Copper**][**Composite copper and copper**]-clad steel.
8. Conductor Support Strap: Copper strap, wound around conductors and messenger the full length of the cable.

G. Aluminum Secondary-Voltage Line Conductors: [**Aluminum conductor, steel reinforced, complying with ASTM B232/B232M**][**Covered aluminum conductor, steel reinforced, complying with ICEA S-70-547, with HDPE or XLP covering**], [**60 mil (1.52 mm)**]<**Insert value**> thick.

H. Copper Secondary-Voltage Line Conductors: [**Bare hard-drawn copper, complying with ASTM B1 and ASTM B8**][**Covered hard-drawn copper, complying with ICEA S-70-547, with HDPE or XLP covering**], [**60 mil (1.52 mm)**]<**Insert value**> thick.[**Neutral-supported, secondary service-drop cable.**]

I. Racked Secondary Conductors, 600 V and Less: [**Copper, insulated with XLP, complying with NEMA WC 70/ICEA S-95-658**]<**Insert conductor and insulation combination**>.

J. Neutral-Supported, Secondary Service-Drop Cable, 600 V and Less: Insulated conductors with bare neutral, complying with ICEA S-76-474, and using the following combination of materials:

1. Conductors and Neutral: [**Copper with copper-clad-steel neutral**][**Aluminum with bare Alloy 1350 aluminum neutral**][**Aluminum with ACSR neutral**].
2. Insulation: [**XLP, complying with NEMA WC 70/ICEA S-95-658**][**High-modular-weight, low-density polyethylene**][**Weather-resistant polyolefin, complying with ICEA S-70-547**].

K. Connectors, Splices, and Conductor Securing and Protecting Components: Items include wire clamps, ties, conductor armor, fittings, connectors, and terminals. Listed for the specific applications and conductor types and combinations of materials used. Descriptions as follows for various applications:

1. Copper to Copper: Copper alloy, complying with UL 486A-486B.
2. Aluminum Composition to Aluminum Composition: Aluminum alloy, complying with UL 486A-486B.
3. Copper to Aluminum Composition: Type suitable for this purpose, complying with UL 486A-486B.
4. Connectors and Splices for Secondary Conductors: Listed and labeled for the conditions and materials involved in each application.
5. Taps for Medium-Voltage Line Conductors: Hot-line clamps, screw type, with concealed threads and bare, hard-drawn copper stirrups. Listed for the combination of materials being connected.
6. Splices under Tension: Compression type with strength exceeding the conductors spliced.
7. Splices and Terminations for Covered Conductors: As recommended by conductor manufacturer for conductor and covering combination and for specific materials and physical arrangement of

each splice.

8. Splices and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Section 260513 "Medium-Voltage Cables."

2.2 WOOD POLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Ace Pole Company**]
2. [**Baxter, J. H. & Co**]
3. [**Bell Lumber and Pole Company**]
4. [**Brown Wood Preserving Co., Inc.**]
5. [**Dayton Superior Corporation**]
6. [**Koppers Performance Chemicals**]
7. [**McFarland Cascade**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Ace Pole Company**]
2. [**Baxter, J. H. & Co**]
3. [**Bell Lumber and Pole Company**]
4. [**Brown Wood Preserving Co., Inc.**]
5. [**Dayton Superior Corporation**]
6. [**Koppers Performance Chemicals**]
7. [**McFarland Cascade**]
8. <**Insert manufacturer's name**>

C. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with [**creosote**][**pentachlorophenol,**][**ammoniacal copper arsenate,**][**ammoniacal copper zinc arsenate**][**chromated copper arsenate**].

D. Wood Species: [**Douglas fir**][**Lodgepole pine**][**Western larch**][**Southern yellow pine**]<**Insert wood species selected from ATIS O5.1**>.

E. Pole Marking:

1. Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft (3 m)** from the pole butt for poles **50 ft (15 m)** long or less.
2. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch (65 mm)** high, with aluminum nails.

F. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

2.3 CONCRETE POLES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Accord Industries**]
2. [**Bayshore Concrete Products Corporation**]
3. [**CPI Concrete Products**]
4. [**StressCrete Group**]
5. [**Valmont Industries, Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Accord Industries**]
2. [**Bayshore Concrete Products Corporation**]
3. [**CPI Concrete Products**]
4. [**StressCrete Group**]
5. [**Valmont Industries, Inc.**]
6. <**Insert manufacturer's name**>

C. Description: Spuncast prestressed concrete, complying with requirements of ASTM C1089.

1. Comply with requirements of RUS Bulletin 1724E-216.

D. Design: Base design on calculation of strength required by IEEE C2 or indicated on Drawings, whichever is greater. Design must be suitable for installation at a location where annual temperature range is between [**minus 4 deg F and plus 100 deg F (minus 20 deg C and plus 38 deg C)**]<**Insert design temperature range at site location**>. Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.

E. Shaft: Hollow, for poles at overhead-to-underground connections. Provide metric designator 91 (trade size 3-1/2) minimum cable raceway capacity, with [**conduit elbow**][**cable entry port**] at base.

F. Water Absorption: Not more than 3 percent.

G. Surface: Smooth, hard, nonporous, and resistant to [**soil acids**][**road salts**][**frost and freezing damage**].

H. Pole Marking:

1. Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft (3 m)** from the pole butt for poles **50 ft (15 m)** long or less.
2. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch (65 mm)** high.

2.4 CROSSARMS

A. Description: [**Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade**][**Galvanized, steel angles**], and complying with IEEE C2 for required climbing space and wire clearances.

B. Braces: Galvanized, flat, ferrous-metal units; **1/4 inch (6 mm)** thick by **1-1/4 inch (30 mm)** wide, minimum, with length to suit crossarm dimensions.

2.5 GUYS AND ANCHORS

A. Guy Strand Assemblies: Cable and attachment assemblies must have uniform minimum breaking strength of the cable.

1. Cable: Seven strands. [**Zinc-coated steel, complying with ASTM A475**][**Aluminum-clad steel, complying with ASTM B416**][**Copper-clad steel, complying with ASTM B228**]. Breaking strength must be not less than [**10,000 lb (45 kN)**]<**Insert value**>.
2. Cable Termination:

a. Thimble eye.
b. Hooks and guy strain plates, complying with IEEE C135.1.
c. Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.

B. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.

1. Power-installed screw-type anchors.

a. **15 inch (380 mm)** screw; with rod **8 ft (2.4 m)** long by **1-1/2 inch (38 mm)** in diameter. Rated at **10,000 lb (45 kN)** when installed.
b. Guy anchors must have strength and holding area as required for anchor load and soil conditions at location of that anchor.

2. <**Insert anchor size or type**>.

C. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Installation of Guys and Anchors" Article.

D. Guy Markers: Round, of vinyl or PVC material, [**white**][**yellow**] color, **8 ft (2.4 m)** long. Shatter resistant at temperatures below **0 deg F (minus 18 deg C)**.

2.6 HARDWARE AND ACCESSORIES

A. Description: Ferrous-metal items include, but are not limited to, bolts, nuts, washers, crossarm gains and braces, insulator pins, anchor rods, anchors, eyebolts, staples, and transformer brackets.

1. Comply with IEEE C135.1, IEEE C135.2, ANSI C135.4, ANSI C135.22, and RUS Informational Publication 202-1 listings[**with the exception that base material must be malleable iron or ductile iron, and finish must be hot-dip galvanized**].

B. Insulator Brackets: Hot-dip galvanized steel, style as indicated, designed to hold vertical-post-type or pin-type insulators, with [**one**][**two**]-bolt attachment to pole.

C. Secondary Insulator Racks: Hot-dip galvanized steel, style as indicated, with smooth, rounded 12 gage struts designed to support [**two**][**three**][**four**] spool insulators for attachment of secondary drop conductors. Spool spacing of [**4 inch (100 mm)**][**8 inch (200 mm)**][**12 inch (300 mm)**].

D. Pole Riser Shields: Galvanized steel with [**boot**][**backplate**][**vent**].

E. Padlocks: ASTM F883.

1. Class: [**PO1**][**PO2**].
2. Grade: [**1**][**2**][**3**][**3**][**5**][**6**].

3. Option: [**A**][**B**][**C**][**D**][**E**][**F**][**G**].

F. Insulators: Units rated 6 kV and above must be free from radio interference.

1. Porcelain insulators must be wet-process type, complying with the following:

a. Pin: ANSI C29.5.
b. Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.
c. Suspension: ANSI C29.2.
d. Guy Strain: ANSI C29.4.
e. Secondary Spool: ANSI C29.3, Class 53-2.

2. Polymer-composite, fiberglass-reinforced insulators must comply with the following:

a. Line Post: CEA LWIWG-02.
b. Dead End/Suspension: CEA LWIWG-01.
c. Guy Strain: Fiberglass reinforced, epoxy finished. Designed specifically for use in guy assemblies.

G. Grounding Materials: Comply with Section 260526 "Grounding and Bonding for Electrical Systems," using materials listed by RUS for the intended purpose without restriction.

1. Conductors: 4 AWG, minimum; bare, solid, annealed copper, complying with ASTM B8 unless otherwise indicated.
2. Ground Conductor Protectors: PVC or half-round wood molding, [**fir, pressure treated in accordance with AWPA C25**][**cypress**][**cedar**].

2.7 SURGE ARRESTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Hubbell Utility Solutions; Hubbell Incorporated**]
5. [**MacLean Power Systems**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Hubbell Utility Solutions; Hubbell Incorporated**]
5. [**MacLean Power Systems**]
6. <**Insert manufacturer's name**>

C. Distribution-Class Surge Arresters: [**Porcelain**][**Polymer**]-enclosed, gapless, metal-oxide type[**with automatic-indicating type, ground-lead disconnection feature**], complying with IEEE C62.11 and NEMA LA 1.

D. Intermediate-Class Surge Arresters: [**Porcelain**][**Polymer**]-enclosed, gapless, metal-oxide type, complying with IEEE C62.11 and NEMA LA 1.

1. Voltage Rating: [**3**][**6**][**9**][**10**][**12**][**15**][**27**][**30**][**36**] kV[**, at the altitude of Project,**] unless otherwise indicated.

2.8 CUTOUTS, SWITCHES, AND FUSES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
3. [**Hubbell Utility Solutions; Hubbell Incorporated**]
4. [**Joslyn Hi-Voltage**]
5. [**MacLean Power Systems**]
6. [**S&C Electric Company**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
3. [**Hubbell Utility Solutions; Hubbell Incorporated**]
4. [**Joslyn Hi-Voltage**]
5. [**MacLean Power Systems**]
6. [**S&C Electric Company**]
7. <**Insert manufacturer's name**>

C. Description: Medium-voltage disconnect, protective[**, and bypass**] units must be rated for the line-to-line voltage of the systems in which installed, unless higher ratings are indicated. BIL ratings are [**45**][**60**][**75**][**95**][**150**][**200**] kV.

1. Momentary Current Rating of Switching Devices: [**20**][**40**]<**Insert value**> kA, asymmetrical at nominal system operating voltage.
2. Fuse Characteristics: Time-current characteristics for each set of fuses selected in accordance with published recommendations of manufacturer of component protected by the fuses and coordinated with upstream and downstream protective devices. Prepare time-current coordination curves in accordance with IEEE 242 that illustrate optimum coordination of devices in this Project.
3. Interrupting Rating of Fuses: <**Insert value**> symmetrical A at nominal system operating voltage.

D. Fuse Cutouts: [**Open**][**enclosed**] type, rated [**100**][**200**] A, continuous, complying with ANSI C37.42.

1. Fuses: Enclosed link, [**Type K**][**Type T**], complying with ANSI C37.42.
2. Fuse Current Rating: 150 percent of the transformer full-load current unless otherwise indicated.
3. Switching Application: Include switch link instead of fuse.
4. Switch Current Interrupting Rating: [**Transformer magnetizing current**]<**Insert value**>.

E. Fused Switches: Single-pole, manual units.

1. Switch Rating: [**400**][**600**] A(rms) continuous and load-current interrupting.
2. Fuses: Dropout-type power fuses.

F. Nonfused Switches: Single-pole, manual units, rated [**100**][**200**][**400**][**600**] A(rms) continuous.

G. Group-Operated, Load-Interrupter Switches: [**Fused**][**Nonfused**], three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.

1. High-pressure contact type, complying with ANSI C37.32.
2. Factory assembled to suit specific configuration and mounting conditions for this Project.
3. Operating Handle: Padlock equipped.
4. Current Interrupting Rating: Equal to continuous current rating of switch.
5. Fuses: Nondropout power type.

H. Group-Operated, Air-Break (Nonloadbreak) Switches: Three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.

1. Comply with ANSI C37.32.
2. Factory assembled to suit specific configuration and mounting conditions for this Project.
3. Operating Handle: Padlock equipped.
4. Suitable for field conversion to load-interrupter switch by adding interrupter modules.

2.9 POLE-MOUNTED DISTRIBUTION TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Howard Industries, Inc**]
5. [**Kuhlman Electric Corporation**]
6. [**Pauwels Transformers**]
7. [**Pioneer Transformers Ltd**]
8. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
4. [**Howard Industries, Inc**]
5. [**Kuhlman Electric Corporation**]
6. [**Pauwels Transformers**]
7. [**Pioneer Transformers Ltd**]
8. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
9. <**Insert manufacturer's name**>

C. Description: Single-phase, two-winding, [**single**][**two**]-bushing, liquid-filled, self-cooled, pole-mounting distribution type, suitable for external fuse and surge suppressor protection; complying with IEEE C 57.12.00, and tested in accordance with IEEE C 57.12.90[**.**][**and with the following additional requirements:**]

1. Cooling Class: OA.

2. Temperature Rise: 65 deg C.
3. Insulating Liquid:

    a. Mineral oil, ASTM D3487, Type II.
    b. High molecular weight, mineral oil based, and UL listed as less-flammable type.
    c. Biodegradable insulating and cooling liquid, UL listed as less flammable type.
    d. Identification: Label the transformer as "non-PCB" and place manufacturer's name and type of fluid on the nameplate.

D. BIL: [**95**][**75**][**60**] kV.

E. Primary Voltage: <**Insert voltage**>.

F. Taps: [**Two, 2.5 percent above and below**][**Four, 2.5 percent below**], high-voltage and full-load rated.[**Tap changer must have an external operating handle.**]

G. Mounting Brackets: [**Single**][**Double**], integral; suitable for pole mounting, individually or in cluster, or on crossarm.

H. Minimum Efficiency: Class 1, as defined by NEMA TP 1, based on test results that comply with requirements of NEMA TP 2.

I. Bushings: Creepage distance must exceed nominal value standard for unit rating by at least 75 percent.

J. Hardware: Stainless steel.

K. Tank and Cover: Stainless steel, complying with ASTM A167, Type 304 or 304L, with paint coating exterior finish system complying with IEEE C57.12.28, including manufacturer's standard color finish coat.

L. Show transformer kiloampere capacity using **2-1/2 inch (65 mm)** numerals placed near the low-voltage bushings.

2.10 PRIMARY METERING PRODUCTS

A. Primary Metering Equipment:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**GE Power; General Electric Company**]
    c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
    d. [**Landis+Gyr Inc.**]
    e. [**Schweitzer Engineering Laboratories, Inc.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]

b. [**GE Power; General Electric Company**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Landis+Gyr Inc.**]
e. [**Schweitzer Engineering Laboratories, Inc.**]
f. <**Insert manufacturer's name**>

B. Metering Transformers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**GE Power; General Electric Company**]
b. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
c. [**Kuhlman Electric Corporation**]
d. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**GE Power; General Electric Company**]
b. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
c. [**Kuhlman Electric Corporation**]
d. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
e. <**Insert manufacturer's name**>

C. Description: Outdoor current and potential transformers, designed for crossarm mounting, complying with IEEE C57.13, and having the following features:

1. BIL: [**45**][**60**][**75**][**95**][**150**][**200**] kV.
2. Secondary connection box arranged for conduit connection.
3. Potential-Transformer Voltage Rating: [**2.4**][**4.16**][**7.2**][**12.0**][**12.47**]<**Insert value**> kV to 120 V(ac), 60 Hz.
4. Potential-Transformer Accuracy Class: Minimum 0.3 at [**75**]<**Insert value**> VA burden.
5. Voltage Rating: [**2.4**][**4.16**][**7.2**][**12.0**][**12.47**]<**Insert value**> kV.
6. Current Rating: <**Insert value**> to 5 A.
7. Accuracy Class: Minimum 0.2 at [**50**]<**Insert value**> VA burden.

D. Watt-Hour Meter: Outdoor solid-state unit, [**with demand register,**][**arranged for pulse initiation,**] complying with ANSI C12.10, and including the following ratings and features:

1. Form: [**8S**][**9S**].
2. Element: [**2**][**2-1/2**][**3**].
3. Voltage: 120 V.
4. Current: 2-1/2 A.
5. Frequency: 60 Hz.
6. Kilowatt-Hour Register: Five-digit type.
7. Demand-Register Multiplier: A quantity in even hundreds, indicated on meter face.
8. Demand-Register Interval: [**15**][**30**] minutes.
9. Mounting: On matching socket, complying with ANSI C12.7, and complete with automatic current short-circuiting device.
10. Meter Test Block: Matched to meter, and furnished and equipped with open knife switches

designed to isolate each metering component for test.

11. Meter Cabinet: Galvanized steel; weatherproof enclosure with pole-mounting bracket and the following features:

    a. Hinged Door: Arranged for padlocking in closed position.
    b. Size: Adequate to house meter and other equipment indicated, but not less than **20-by-30-by-11 inch (510-by-760-by-280 mm)** deep.

2.11 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. For each type of product include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Material Certificates: For the following items, from manufacturers:

    a. Wood poles.
    b. Concrete poles.
    c. Wood crossarms.

3. Listing Documentation: Indicate that products comply with requirements specified in "Quality Assurance" Article.
4. Time-Current Coordination Curves: Illustrate optimum coordination of protective devices involved in the Work of this Section.

B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. Factory Tests:

1. Testing Administrant: [**Owner will engage**][**Engage**] qualified pole and crossarm inspection agency to evaluate poles and crossarms.
2. Factory Tests and Inspections:

    a. Inspect poles and crossarms, by, or under supervision of, qualified pole and crossarm inspection agency recognized by authorities having jurisdiction, in accordance with referenced standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified pole and crossarm inspection agency's**] certification of system compliance.

        1) RUS quality mark "WQC" on each item is acceptable in place of inspection as evidence of compliance.

    b. Conduct routine tests of [**transformers**][**medium-voltage switches**][**and**][**metering equipment**] by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with referenced standards. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

3. Nonconforming Work: Units that do not pass tests and inspections will be considered defective.
4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 RIGHT-OF-WAY CLEARANCE AND TREE TRIMMING

A. Clear right of way in accordance with Section 015639 "Temporary Tree and Plant Protection" and Section 311000 "Site Clearing."

B. Clear right of way to maintain minimum clearances required by IEEE C2, unless Drawings indicate greater clearances or greater clearances are required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of **15 ft (4.5 m)** on both sides horizontally and below medium-voltage conductors and **60 inch (1500 mm)** on both sides horizontally and below secondary-voltage conductors. Remove overhanging branches.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install underground power and metering circuits and those circuits indicated to be in raceways in accordance with Section 260543 "Underground Ducts and Raceways for Electrical Systems" and Section 260513 "Medium-Voltage Cables," and make splices and terminations for those circuits in accordance with the applicable Sections.

B. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document must also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Apply warning signs and equipment labels in accordance with Section 260553 "Identification for Electrical Systems."

3.3 INSTALLATION OF MEDIUM-VOLTAGE LINE CONDUCTORS

A. Selection: Install bare conductors unless otherwise indicated.

B. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening, or deformation. Remove damaged sections and splice conductors.

1. String new conductors to "initial" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
2. Conductors Reinstalled or Resagged: String to "final" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.

C. Connections, Splices, and Terminations: Use kits listed for the specific type of connection and combination of materials in the connection or recommended for the specific use by manufacturer of material on which applied.

1. Splice Location: Do not install within **10 ft (3 m)** of a support.
2. Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.
3. Splices and Terminations of Covered Conductors: Comply with manufacturer's published

instructions.

4. Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's published instructions.

D. Armor Rod: Install to protect conductors if line conductors are supported by insulators.

E. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.

F. Support line conductors and taps as follows:

1. Use wire ties for conductor attachment to pin and vertical post insulators unless otherwise indicated.
2. Install wire ties tight against conductor and insulator, and turn ends back and flat against conductor, to eliminate exposed wire ends.
3. Use wire clamps on horizontal post, dead end, and suspension insulators unless otherwise indicated.

3.4 INSTALLATION OF POLES AND CROSSARMS

A. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.

B. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and in accordance with the following:

1. On level ground, set poles so tops of consecutive poles vary not more than **60 inch (1500 mm)** in elevation.
2. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.

C. Set poles in accordance with the following:

1. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
2. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:

    a. Poles up to 35 ft (10.6 m) Long: **24 inch (600 mm)**.
    b. Poles 36 to 60 ft (11 to 18.3 m) Long: **30 inch (760 mm)**.
    c. Poles 61 to 75 ft (18.6 to 22.9 m) Long: **36 inch (900 mm)**.

3. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
4. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain **1 inch (25 mm)** minimum, **2 inch (51 mm)** maximum, (after conductors are installed at required tension) for each **10 ft (3 m)** of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
5. Backfill holes in **6 inch (150 mm)** maximum lifts, and thoroughly tamp each layer before starting the next.
6. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
7. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead

ends; place gains on last two poles on side facing terminal or dead end.

8. Poles Set in Concrete Paved Areas: Install poles with minimum of **6 inch (150 mm)** wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with [**pea gravel**]<**Insert appropriate material**> to a level **1 inch (25 mm)** below top of concrete slab.

D. Field treat factory-treated poles and crossarms as follows:

1. Poles Treated More Than One Year before Installation: Treat portion from **24 inch (600 mm)** above ground line to butt.
2. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
3. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
4. Engage the services of qualified wood pole and crossarm treatment technician to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.

E. Crossarm Installation: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

1. Buck Arms: Install at corners and junction poles unless otherwise indicated.
2. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
3. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
4. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

F. Locate pole numbers to provide maximum visibility from the road or patrol route.

3.5 INSTALLATION OF GUYS AND ANCHORS

A. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inch (900 mm)** or more. Comply with IEEE C2.

1. Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
2. At the anchor end, attach guy strand assembly with preformed grips.

B. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.

C. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio must be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.

D. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inch (150 to 230 mm)** from ground.

E. Install strain insulators to provide a minimum of **12 inch (300 mm)** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators must be loaded to not more than two-thirds of manufacturer's published rating.

F. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

3.6 INSTALLATION OF HARDWARE AND ACCESSORIES

A. Install washers against wood and under nuts, including eyenuts and locknuts.

B. Install nuts and locknuts wrench-tight on threaded connections.

C. Medium-Voltage Line Insulators: Install [**pin**][**or**][**post**] type, except install suspension type at corners, angles, dead ends, and other locations where horizontal forces exceed rated values for pin or line-post-type units.

1. Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.
2. Install horizontal line-post insulators for armless construction.

D. Post-Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.

E. Install spool-type insulators for secondary lines mounted on clevis attachments or secondary racks.

F. Guy Strain Type Insulators: Install [**porcelain**][**fiberglass-reinforced**] units.

3.7 INSTALLATION OF SURGE ARRESTERS

A. Install surge arresters to protect [**distribution**][**metering equipment**][**reclosers**], [**group-operated, load-interrupter switches**], [**aerial-to-underground transitions**], and other items indicated.

1. Units Installed 6000 ft (1800 m) or More above Sea Level: Use arresters specifically rated for this service.

3.8 INSTALLATION OF CUTOUTS, SWITCHES, AND FUSES

A. Hook-Stick-Operated Switches: Install to maximize safe operating access.

B. Group-Operated, Load-Interrupter Switches and Air-Break Switches: Install operating handle **42 inch (1067 mm)** above finished grade.

1. Locking Provisions: Install padlock at hasp.

3.9 INSTALLATION OF PRIMARY METERING PRODUCTS

A. Current and Voltage Transformers: Install secondary conductors between transformers and cabinet in sleeves made of [**galvanized rigid steel**][**intermediate metal**][**PVC**] conduit. Install to prevent collection of moisture in raceway and cabinet system.

B. Meter Cabinet: Mount on pole, **72 inch (1825 mm)** above finished grade to center of cabinet.

1. Make conduit connections with raintight hubs.
2. Install metering transformer secondary leads without splices. Train leads at sides and bottom of enclosure, and secure with wire ties.
3. Install meter and meter test block within cabinet.
4. Install identical phase sequence, and color-code for both potential and current leads.
5. Identify leads using designations consistent with marking on transformer terminals.

3.10 GROUNDING

A. Comply with IEEE C2 grounding requirements.

B. Ground Rods: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch-by-10 ft (19 mm-by-3 m)**][**5/8 inch-by-8 ft (16 mm-by-2.4 m)**] in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install [**two**]<**Insert number**> parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 Ω.
2. Drive ground rods until tops are **12 inch (300 mm)** below finished grade in undisturbed earth.

C. Grounding Conductors:

1. 4 AWG minimum, soft-drawn copper.
2. Conductor Protectors for Wood Poles: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communications service and transformer spaces.
3. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
4. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
5. Transformer Enclosures and Secondary Neutrals: Interconnect and connect to grounding conductor.

3.11 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Furnish instruments and equipment required for tests that comply with NETA Acceptance Testing Specification.
2. Guy Anchors: Test one of each type and capacity installed[**, plus additional units specifically indicated for testing**]. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

    a. Acceptable Test Results: Denoted by movement of less than **3/8 inch (10 mm)** by the holding component of the anchor in the earth or other medium in which it is installed.
    b. Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.

3. Ground Resistance: Comply with Section 260526 "Grounding and Bonding for Electrical Systems." Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.

    a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
    b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground,

tested individually, exceeds 25 Ω, add a ground electrode not less than **10 ft (3 m)** away and interconnect with 2 AWG, minimum, bare conductor buried at least **12 inch (300 mm)** below furnished grade.

4. Aerial Conductor Sag and Tension: Observe procedures used by Contractor to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's product data and published recommendations.
5. Self-Supported, Medium-Voltage Cable: After installation, while cable is isolated, and after terminations are installed and before connecting or energizing, apply DC voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with NEMA WC 70/ICEA S-95-658 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.
6. Neutral-Supported, Secondary Service-Drop Cable: Test for insulation resistance while cable is isolated, before connecting or energizing. Minimum acceptable resistance is 100 MΩ.
7. Existing Surge Arresters: Disconnect and measure resistance between line and ground terminals with a megger test rated 600 V or more. Acceptable resistance values are 300 MΩ and more.
8. New Surge Arresters, Cutouts, and Switches: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.

    a. Verify proper grounding of metallic equipment parts.
    b. Fuses and Disconnect Links: Verify that ratings and characteristics match submittals and comply with system requirements.
    c. Switches:

        1) Manually operate each cutout and switch at least three times, to verify proper operation.
        2) Verify correct contact alignment, blade penetration, travel stops, and arc interrupter operation.

    d. Group-Operated, Load-Interrupter Switches and Air-Break Switches:

        1) Perform mechanical operator tests in accordance with manufacturer's published instructions.
        2) Test resistance to ground of parts to be energized. Acceptable value is 200 000 MΩ.
        3) Perform contact-resistance test across all switch blade contacts. Refer to manufacturer's data for acceptable contact resistance.

    e. Verify that clearances of energized parts and connecting wires comply with IEEE C2 requirements.

9. Distribution Transformers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

    a. Inspect for physical damage, cracked insulators, leaks, tightness of connections, and overall mechanical and electrical integrity.
    b. Perform preenergizing inspections and tests recommended by manufacturer.
    c. Verify proper equipment grounding.
    d. Verify that clearances of terminals and connecting wires comply with IEEE C2.

10. Metering Transformers: Inspect after installation and connection to wires, and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

a. Verify proper connections, tightness of bolted connections, and integrity of mounting provisions.
b. Verify that required grounding and shorting connections provide good contact.
c. Verify that clearances of terminals and connecting wires comply with IEEE C2.
d. Perform electrical tests in accordance with manufacturer's published instructions, including insulation-resistance tests, polarity tests, and turns-ratio and ratio-verification tests.

11. Meters: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

a. Verify tightness of electrical connections.
b. Verify accuracy at 25, 50, 75, and 100 percent of full-rated load and verify all instrument multipliers in accordance with manufacturer's published instructions.

D. Nonconforming Work:

1. Units will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.12 ADJUSTING

A. Pole-Mounted Distribution Transformers: Set voltage taps as directed by Architect.

3.13 CLEANING

A. After completing equipment installation, inspect equipment. Remove spots, dirt, and debris. Repair damaged finish to match original finish. For distribution transformer, use tank touchup paint provided by manufacturer.

1. Clean enclosures internally, on completion of installation, in accordance with manufacturer's published instructions.

END OF SECTION 26 05 43 00A

Task	Specification	Specification Description
26 05 43 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 43 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 43 00	27 11 00 00	Communications Equipment Room Fittings
26 05 43 00	27 13 13 00	Communications Copper Backbone Cabling
26 05 43 00	27 15 33 00	Communications Coaxial Horizontal Cabling

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SECTION 26 05 46 00 - POLES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting standards.
2. Lighting standard accessories.
3. Utility poles.
4. Utility pole accessories.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding components referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
8. [**Section 262726 "Wiring Devices"**][**Section 262726.31 "General-Grade Single Straight-Blade Receptacles"**][**and**][**Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles"**] specify receptacles referenced by this Section.
9. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.
5. Product Certificates: Include product certificate, signed by manufacturers of poles, certifying that products are designed for indicated load requirements in accordance with AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification must be based on design calculations signed and sealed by a professional engineer.
6. Include manufacturer's sample extended warranty language.

B. Samples: Submit finish samples for each exposed lighting pole, standard, and luminaire-supporting

device and for each color and texture specified.

C. Shop Drawings: Prepare and submit the following:

1. Plans, elevations, sections, and [**mounting**][**and**][**attachment**] details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Details of fabrication and assembly of [**poles**][**and**][**pole accessories**].
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's published installations.

D. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports:

1. For each foundation component, by qualified testing laboratory.
2. For each pole, by qualified testing laboratory.

B. Soil test reports.

C. Manufacturer's published instructions.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.5 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed [**pole(s)**][**and luminaire-lowering device(s)**] perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that [**pole(s)**][**and luminaire-lowering device(s)**] perform in accordance with specified requirements and agrees to provide repair or replacement of products that fail to perform as specified within extended-warranty period, including materials that corrode, fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Warranty Period for Corrosion Resistance: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
3. Warranty Period for Color Retention: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Description: <**Insert brief description of desired system, assembly, or equipment**>.

B. Performance Criteria:

1. Regulatory Requirements:

   a. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Utility Approval: Comply with <**Insert name of utility**> requirements.
3. General Characteristics:

   a. Structural Characteristics: Comply with AASHTO LTS-6-M.
   b. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied in accordance with AASHTO LTS-6-M.
   c. Live Load: Single load of **500 lb** distributed in accordance with AASHTO LTS-6-M.
   d. Ice Load: Load of **3 lb/ft2**, applied in accordance with AASHTO LTS-6-M for applicable areas on the Ice Load Map.
   e. Wind Load for Poles Exceeding 50 ft (15 m) Height:

      1) Basic Wind Speed: [**100 mile/h**][**90 mile/h**]<**Insert value from AASHTO LTS-6-M for this Project**>.
      2) Wind Importance Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.
      3) Minimum Design Life: [**50 years**]<**Insert value from AASHTO LTS-6-M**>.
      4) Velocity Conversion Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.

   f. Wind Load for Poles Not Exceeding 50 ft (15 m) Height:

      1) Basic Wind Speed: [**100 mile/h**][**90 mile/h**]<**Insert value from AASHTO LTS-6-M for this Project**>.
      2) Wind Importance Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.
      3) Minimum Design Life: [**25 years**]<**Insert value from AASHTO LTS-6-M**>.
      4) Velocity Conversion Factor: [**1.0**]<**Insert value from AASHTO LTS-6-M**>.

   g. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of [**1.1**]<**Insert number**> to obtain the EPA used in pole selection strength analysis.
   h. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
   i. General Finish Requirements:

      1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2) Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.2 LIGHTING STANDARDS

A. Steel Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American LitePole**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Bridgewell Resources**]
   d. [**Cooper Lighting Solutions; Signify North America Corp.**]
   e. [**E-conolight**]
   f. [**H.E. Williams**]
   g. [**Hapco**]
   h. [**Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
   k. [**LSI Industries**]
   l. [**Millerbernd Manufacturing Company**]
   m. [**NAFCO; brand of Wisconsin Lighting Lab, Inc.**]
   n. [**RAB Lighting**]
   o. [**Ruud Lighting; brand of Cree Lighting; subsidiary of Ideal Industries, Inc.**]
   p. [**Union Metal Industries Corp.**]
   q. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

   a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
   b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
   c. General Finish Requirements:

      1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
      2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

   d. Carbon Steel Poles: Comply with ASTM A500/A500M, Grade B carbon steel with a minimum yield of **46,000 psig**; one-piece construction up to **40 ft** in height with access handhole in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

e. Stainless Steel Poles: Comply with [**ASTM A240/A240M**][**ASTM A666**], stainless steel with a minimum yield of **55,000 psig**; one-piece construction up to **40 ft** in height with access handhole in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

f. Steel Mast Arms: [**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate.

g. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor fitting welded to lighting standard, allowing the bracket to be bolted to the lighting standard-mounted adapter, then bolted together with [**stainless steel**][**galvanized-steel**] bolts.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

h. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to lighting standard top.

i. Grounding and Bonding Lugs: Welded **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

j. Steps: Fixed steel, with nonslip treads.

1) For climbing positions, install at **15 inch** vertical spacing, alternating on opposite sides of lighting standard, oriented 180 degrees from each other; first step must be at an elevation **10 ft** above finished grade.
2) For working positions, install steps on opposite side of lighting standard, oriented 180 degrees from each other at the same elevation.

k. Handhole: Oval shaped, with minimum clear opening of **2-1/2-by-5 inch**, with cover secured by stainless steel captive screws.

l. Intermediate Handhole and Cable Support: Weatherproof, **3-by-5 inch** handhole located at midpoint of lighting standard, with cover for access to internal welded attachment lug for electric cable support grip.

m. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.

n. Platform for Lamp Ballast Servicing: Factory fabricated of steel, with finish matching that of lighting standard.

o. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

p. Galvanized Finish: After fabrication, hot-dip galvanize in accordance with ASTM A123/A123M.

q. Factory-Painted Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces in accordance with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

r. Powder-Coat Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces in accordance with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder-coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Powder Coat: Comply with AAMA 2604.

a) Electrostatic-applied powder coating; single application and cured to a minimum **2.5 to 3.5 mil** dry film thickness. Coat interior and exterior of lighting standard for equal corrosion protection.
b) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

B. Aluminum Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American LitePole**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Bridgewell Resources**]
d. [**Cooper Lighting Solutions; Signify North America Corp.**]
e. [**E-conolight**]
f. [**H.E. Williams**]
g. [**Hapco**]
h. [**Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
k. [**LSI Industries**]
l. [**Lyte Poles; brand of DWM Holdings, Inc.**]
m. [**NAFCO; brand of Wisconsin Lighting Lab, Inc.**]
n. [**Ruud Lighting; brand of Cree Lighting; subsidiary of Ideal Industries, Inc.**]
o. [**Sentry Electric, LLC**]

p. [**Union Metal Industries Corp.**]
q. [**Valmont Industries, Inc.**]
r. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. [**Seamed**][**Seamless**], extruded structural tube complying with ASTM B221, [**Alloy 6063-T6**][**Alloy 6061-T6**], with access handhole in in lighting standard wall.

1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
2) Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

e. Mast Arms: [**Aluminum**][**Steel**][**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate.
f. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor fitting welded to lighting standard, allowing the bracket to be bolted to the lighting standard-mounted adapter, then bolted together with [**stainless steel**][**galvanized-steel**] bolts.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

g. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to lighting standard top.
h. Grounding and Bonding Lugs: Bolted **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
i. Handhole: Oval shaped, with minimum clear opening of **2-1/2 by 5 inch**, with cover secured by stainless steel captive screws.
j. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
k. Aluminum Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2) Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3) Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin;

Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.

4) Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

l. Factory-Painted Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

m. Powder-Coat Finish: Comply with NAAMM/NOMMA AMP 500 recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Powder coat must comply with AAMA 2604.

a) Electrostatic applied powder coating; single application with a minimum **2.5 to 3.5 mil** dry film thickness; cured in accordance with manufacturer's published instructions. Coat interior and exterior of lighting standard for equal corrosion protection.
b) Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**].

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as to substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

C. Fiberglass Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alliance; a division of GEOTEK**]
b. [**Bridgewell Resources**]
c. [**CMT; a Valmont Company**]
d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**PLP Composite Technologies, Inc**]
f. [**Shakespeare; a Valmont Company**]
g. [**Valmont Industries, Inc.**]
h. [**Whately; a Valmont Company**]
i. [**Wood Preservers, Inc.**]
j. **<Insert manufacturer's name>**

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. Designed specifically for supporting luminaires, with factory-formed cable entrance and handhole.
e. Not less than 65 percent by weight of fiberglass roving, with resin and pigment making up the remainder.
f. Roving must be continuously applied with uniform tension, with multiple layers placed to meet axial and compressive strength requirements.
g. Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
h. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
i. Surface Finish: Smooth and uniform along surface of lighting standard.
j. Paint Finish: Pigmented polyurethane, with a minimum dry film thickness of **1.5 mil**. Polyurethane may be omitted if the surface layer of the lighting standard is inherently UV inhibited.
k. Mast Arms: [**Aluminum**][**Steel**][**Fiberglass**][**Single-arm**][**Truss**][**Davit**] type, continuously welded to lighting standard attachment plate. Material and finish same as plate. Adaptor plate must be steel hot-dip galvanized in accordance with ASTM A153/A153M or Alloy 6061-T6 aluminum encased within fiberglass roving, allowing the mast arm adaptor to be bolted to the lighting standard.
l. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1) Adaptor Fitting: Steel, hot-dip galvanized in accordance with ASTM A153/A153M, or Alloy 6061-T6 aluminum, permanently bonded within fiberglass roving, allowing the bracket to be bolted to the lighting standard-mounted adapter. Bolt together with [**stainless steel**][**galvanized-steel**] bolts; use anti-seize compound when bolting dissimilar metals.
2) Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match lighting standard material and finish.

m. Pole-Top Tenons: Steel, hot-dip galvanized in accordance with ASTM A153/A153M, or Alloy 6061-T6 aluminum, permanently bonded to the fiberglass shaft. Fabricated to support luminaire or luminaires and brackets indicated.
n. Handhole: Oval shaped, with minimum clear opening of **2-1/2 by 5 inch**, with cover secured by stainless steel captive screws.
o. Grounding: Bare, stranded copper, 6 AWG, [**suspended inside of lighting standard**][**inside 3/4 inch conduit fastened to the interior of the lighting standard**], connected to luminaire(s), ground lug near handhole, and ground rod.
p. Grounding and Bonding Lugs: Bolted **1/2 inch** threaded lug, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

4. Other Available Features Required by the Project:

a. Resin Color: [**Black**][**Dark**][**Bronze**]<**Insert color**>; uniform coloration throughout entire wall thickness.
b. Anchor Base: Integral galvanized-steel or aluminum casting, enclosing and permanently bonded to the exterior of the fiberglass shaft.
c. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

D. Laminated Wood Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bell Lumber and Pole Company**]
b. [**Hughes Brothers, Inc.**]
c. [**Laminated Wood Systems, Inc.**]
d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**McFarland Cascade**]
f. [**Timber Technologies, LLC**]
g. [**TimberWood Products; J.H. Baxter & Co.**]
h. [**Valmont Industries, Inc.**]
i. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. Species and Grades for Structural Laminated Timber: Complying with APA A190.1. Use [**Southern pine**][**Douglas fir**][**Alaska cedar**][**any species listed in APA 117**], engineered and fabricated to withstand indicated structural loads without exceeding allowable design working stresses in accordance with [**APA 117**][**AWPA/ANSI O5.2**].
e. Features include [**wood bracket**][**wood crossarm**][**lighting standard-top adaptor**]<**Insert items**> for mounting luminaire(s), metal lighting standard cap, and concealed raceway path connected to access handhole.
f. Mounting Provisions: [**Embedded**]<**Insert description of other mounting unless detailed on the Drawings**>.
g. Appearance Grade: Architectural appearance grade complying with AITC 110.
h. Preservative Treatment:

1) Exposure: Comply with [**AWPA U1, Use Category UC4A**][**AWPA U1, Use Category UC4B**][**AWPA U1, Use Category UC4C**].
2) Treatment after Dressing and End Cutting: Comply with AWPA M4 for surface cuts to a depth of more than **1/16 inch**.

i. Adhesive: Wet-use type complying with ASTM D2559.
j. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
k. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.
l. Finish: [**Natural, unstained wood**][**Semitransparent stain applied after erection**][**Factory-applied semitransparent stain**], color as selected by Architect.

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as to substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

E. Wood Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Pole & Timber**]
b. [**Baldwin Pole & Piling Co., Inc.**]
c. [**Bell Lumber and Pole Company**]
d. [**Cavawood Architectural Products**]
e. [**Cobb Lumber Company**]

f. [**Cox Utility Products Division**]
g. [**Guelph Utility Pole Co., Ltd.; a Stella-Jones company**]
h. [**Koppers Performance Chemicals**]
i. [**Langdale Forest Products Company**]
j. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
k. [**McFarland Cascade**]
l. [**Stella-Jones**]
m. [**T.R. Miller Mill Co., Inc.**]
n. [**Texas Electric Cooperatives, Inc.**]
o. [**Thomasson Company**]
p. [**TimberWood Products; J.H. Baxter & Co.**]
q. [**United Wood Treating Company**]
r. [**Wood Preservers, Inc.**]
s. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
c. General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

d. [**Douglas fir**][**Southern yellow pine**], [**machine trimmed by turning,**] for wood species used; and bored, roofed, and grained before treatment.

1) Pole Brand: Brand the manufacturer's trademark and date of treatment, height and class of lighting standard, wood species, preservation code, and retention. Brand must be placed so that the bottom of the brand is minimum **10 ft** from lighting standard butt.
2) Mounting Provisions: Embedded.

e. Preservative Treatment: Treat in accordance with [**AWPA U1, Use Category UC4A**][**AWPA U1, Use Category UC4B**][**AWPA U1, Use Category UC4C**].
f. Luminaire Brackets: Comply with NEMA/ANSI C136.13.

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1) Materials: Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.
2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after

fabrication unless otherwise indicated.

F. Prestressed Concrete Lighting Standard:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Baldwin Pole & Piling Co., Inc.**]
   b. [**Holophane; an Acuity Brands company**]
   c. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
   d. [**Lonestar Prestress Mfg., Inc.**]
   e. [**NOV Ameron**]
   f. [**Pre-Cast Specialties, Inc.**]
   g. [**Seminole Pole, Inc.**]
   h. [**StressCrete Group**]
   i. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain lighting standards from single manufacturer or producer**][**For lighting standards, obtain each color, grade, finish, type, and variety of lighting standard from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

   a. Comply with requirements in Article 410 of NFPA 70 for luminaire supports.
   b. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
   c. General Finish Requirements:

      1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
      2) Appearance of the Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

   d. Comply with ASTM C1089[**and manufactured by centrifugal spin-casting process**][**and manufactured by static-casting method**].

      1) Shape: [**Round, tapered**][**Round, straight**][**Square, tapered**][**Square, straight**].
      2) Mounting Provisions: [**Steel butt flange for bolted mounting to foundation or breakaway support**][**Embedded**].
      3) Finishing: Capped at top and plugged at bottom. Seat each reinforcing strand with epoxy adhesive.
      4) Grounding: Continuous copper ground wire cast into lighting standard. Terminate at top of lighting standard[**and attach to 24 inch lighting rod**].
      5) Raceway: Smooth, internal, and not less than **3 inch** in diameter.

   e. Concrete: Minimum 28-day compressive strength of [**7000 psi**]<**Insert value**>.
   f. Cured with wet steam and aged for a minimum of 15 days prior to installation.
   g. Reinforcement: [**Reinforcing bars complying with ASTM A615/A615M**][**Cold-drawn spiral wire complying with ASTM A1064/A1064M**][**Prestressing strand, 270 K, complying with ASTM A416/A416M**].
   h. Surface Treatment: Hard, nonporous, and resistant to water, frost, and road and soil chemicals; and must have a maximum water-absorption rate of 3 percent.

i. Finish Texture: [**Standard form**][**Polished exposed aggregate**][**Etched exposed aggregate**].

1) Exposed aggregate must be of <**Insert aggregate type selected from manufacturers' lists**> type.

j. Nameplate: Aluminum cast into lighting standard wall at approximately **5 ft** above ground line, listing name of manufacturer, the Project identifier, overall height, and approximate weight.

k. Pole Brackets: Comply with NEMA/ANSI C136.31.

4. Other Available Features Required by the Project:

a. Fasteners: [**Stainless steel**][**Galvanized steel**]<**Insert finish or grade**>, size and type as determined by manufacturer. Compatible with lighting standards as well as the substrates to which lighting standards are fastened and may not cause galvanic action at contact points.

2.3 LIGHTING STANDARD ACCESSORIES

A. Duplex Receptacle: Ground-fault circuit interrupter type, 120 V(ac), 20 A in a weatherproof assembly.

1. [**Surface mounted**][**Recessed**][**12 inch**]<**Insert dimensions**> above finished grade.

a. UL 50E, [**Type 3R**][**Type 4X**], nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.

b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.

B. Minimum 1800 W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

D. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept [**ballast(s)**][**indicated accessories**]. Include removable flanged access cover secured with bolts or screws.

E. Decorative accessories, supplied by decorative pole manufacturer, include the following:

1. Banner Arms: <**Insert material**>.
2. Flag Holders: <**Insert material**>.
3. Ladder Rests: <**Insert material**>.

F. Lowering System for Luminaires:

1. System Description: Capable of lowering luminaire [**assembly**]to a service position within **36 inch** of finished grade in winds up to **30 mile/h**. Provide manual plug connection to electrical power accessible in lowered position. Assembled system of pole, luminaire, and lowering device must be capable of loads specified in "Performance Requirements" Article.
2. Compatibility of Material: Materials for attachment and connection of luminaire-mounting assembly, lowering device, lowering cable, and portable winch must be compatible to avoid corrosion and electrolysis.
3. Structural and Mechanical Design Safety Factor: 5.0, minimum, for static and dynamic loads of

load-bearing components, including cable.

4. Luminaire-Mounting and Disconnect Arrangement: Multiple [**ring**][**carriage**]-mounted luminaires, arranged for lowering and rising as a group.

    a. Electrical cable for normal operating power to luminaires must manually disconnect inside pole base, using weatherproof multi-pin connector, and must be arranged to move within the pole during lowering and rising of luminaire assembly.
    b. Electrical cable for normal operating power to luminaires must automatically disconnect at weatherproof multi-pin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnect when luminaire or luminaire assembly is raised to the operating position.

5. Lowering Device: Weatherproof, cast-aluminum housing, and multiple mechanical latches. Moving parts of latching assembly must be located in the portion of the unit that is lowered to servicing position. Positive latching in the operating position must be indicated to the operator at the base of the pole by a clear visual signal or by other means acceptable to Owner or authorities having jurisdiction.
6. Lowering Cable: [**Zinc-electroplated-steel**][**or**][**stainless steel**] aircraft cable.
7. Portable Winch: [**Manual**][**120 V electric**] type. [**One**]<**Insert number**> required.

    a. Winch Power Connection: Cord and plug.
    b. Winch Raise-Lower Control: Remote-control station with [**15 ft**]<**Insert dimension**> of cable.

G. Mounting Hardware:

1. Anchor Bolts: Manufactured [**to ASTM F1554, Grade 55,**]with a minimum yield strength of **55,000 psi**.

    a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
    b. [**Bent**][**Headed**] rods <**Insert dimension**> in diameter by <**Insert dimension**> in length.
    c. Threading: [**Uniform National Coarse**][**Uniform National 8**], Class 2A.

2. Nuts: ASTM A563/A563M, Grade A, Heavy-Hex.

    a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
    b. [**Two**][**Four**]<**Insert number**> nuts provided per anchor bolt[**, shipped with nuts preassembled to the anchor bolts**].

3. Washers: ASTM F436/F436M, Type 1.

    a. Galvanizing: [**Hot-dip galvanized in accordance with ASTM A153/A153M, Class C**][**Mechanically deposited galvanization in accordance with ASTM B695, Class 50**].
    b. [**One**][**Two**]<**Insert number**> washer(s) provided per anchor bolt.

2.4 UTILITY POLES

A. Wood Utility Pole:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ace Pole Company**]
b. [**Baxter, J. H. & Co**]
c. [**Bell Lumber and Pole Company**]
d. [**Brown Wood Preserving Co., Inc.**]
e. [**Dayton Superior Corporation**]
f. [**Koppers Performance Chemicals**]
g. [**McFarland Cascade**]
h. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain poles from single manufacturer or producer**][**For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with [**creosote**][**pentachlorophenol**][**ammoniacal copper arsenate**][**ammoniacal copper zinc arsenate**][**and**][**chromated copper arsenate**].
b. Wood Species: [**Douglas fir**][**Lodgepole pine**][**Western larch**][**Southern yellow pine**]<**Insert wood species selected from ATIS O5.1**>.
c. Pole Marking:

1) Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft** from the pole butt for poles **50 ft** long or less.
2) Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch** high, with aluminum nails.

d. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

B. Concrete Utility Pole:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Accord Industries**]
b. [**Bayshore Concrete Products Corporation**]
c. [**CPI Concrete Products**]
d. [**StressCrete Group**]
e. [**Valmont Industries, Inc.**]
f. <**Insert manufacturer's name**>

2. Source Limitations: [**Obtain poles from single manufacturer or producer**][**For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties**].
3. Standard Features:

a. Spun-cast prestressed concrete, complying with requirements of ASTM C1089.

1) Comply with requirements of RUS Bulletin 1724E-216.

b. Design: Base design on calculation of strength required by IEEE C2 or indicated on the Drawings, whichever is greater. Design must be suitable for installation at a location where annual temperature range is between [**minus 4 deg F and plus 100 deg F**]<**Insert design**

temperature range at site location>. Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.

c. Shaft: Hollow, for poles at overhead-to-underground connections. Provide metric designator 91 (trade size 3-1/2) minimum cable raceway capacity, with [**conduit elbow**][**cable entry port**] at base.

d. Water Absorption: Not more than 3 percent.

e. Surface: Smooth, hard, nonporous, and resistant to [**soil acids**][**road salts**][**frost and freezing damage**].

f. Pole Marking:

1) Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft** from the pole butt for poles **50 ft** long or less.

2) Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch** high.

2.5 UTILITY POLE ACCESSORIES

A. Crossarms:

1. Description: [**Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade**][**Galvanized, steel angles**], and complying with IEEE C2 for required climbing space and wire clearances.
2. Braces: Galvanized, flat, ferrous-metal units; **1/4 inch** thick by **1-1/4 inch** wide, minimum, with length to suit crossarm dimensions.

B. Guys and Anchors:

1. Guy Strand Assemblies: Cable and attachment assemblies must have uniform minimum breaking strength of the cable.

a. Cable: Seven strands. [**Zinc-coated steel, complying with ASTM A475**][**Aluminum-clad steel, complying with ASTM B416**][**Copper-clad steel, complying with ASTM B228**]. Breaking strength must be not less than [**10,000 lb**]<**Insert value**>.

b. Cable Termination:

1) Thimble eye.

2) Hooks and guy strain plates, complying with IEEE C135.1.

3) Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.

2. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.

a. Power-installed, screw-type anchors.

1) **15 inch** screw; with rod **8 ft** long by **1-1/2 inch** in diameter. Rated at **10,000 lb** when installed.

2) Guy anchors must have strength and holding area as required for anchor load and soil conditions at location of that anchor.

b. <**Insert anchor size or type**>.

3. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Installation of Guys and Anchors" Subparagraph in "Installation of Utility Poles" Article.
4. Guy Markers: Round, of vinyl or PVC material, [**white**][**yellow**] color, **8 ft** long. Shatter resistant at temperatures below **0 deg F**.

PART 3 - EXECUTION

3.1 INSTALLATION OF FOUNDATIONS FOR POLES AND LIGHTING STANDARDS

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Precast Foundations: Factory fabricated, with structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

C. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.

1. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.

D. Direct-Buried Foundations: Install to depth indicated on the Drawings, but not less than [**one-sixth of pole height**][**as indicated**]. Add backfill [**in 6 to 9 inch layers, tamping each layer before adding the next**][**as indicated on the Drawings**]<**Insert requirement**>. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

E. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on the Drawings, but not less than [**one-sixth of pole height**][**as indicated**]. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

1. Make holes **6 inch** in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of **3000 psi** at 28 days and finish in a dome above finished grade.
3. Use a short piece of **1/2 inch** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

F. Anchor Bolts: Install plumb using manufacturer-supplied [**steel**][**plywood**] template, uniformly spaced.

3.2 INSTALLATION OF LIGHTING STANDARDS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Hot Work: NFPA 51B.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Alignment: [**Align foundations and lighting standards for optimum directional alignment of luminaires and their mounting provisions on lighting standards**][**Align lighting standards as indicated**].
2. Clearances: Maintain the following minimum horizontal distances of lighting standards from surface and underground features unless otherwise indicated on the Drawings:

    a. Fire Hydrants and Water Piping: [**60 inch**]<**Insert dimension**>.
    b. Water, Gas, Electric, Communications, and Sewer Lines: [**10 ft**]<**Insert dimension**>.
    c. Trees: **15 ft** from tree trunk.
    d. <**Insert features and clearance dimensions**>.

3. Concrete Lighting Standard Foundations: Set anchor bolts in accordance with anchor-bolt templates furnished by manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
4. Foundation-Mounted Lighting Standards: Mount lighting standards with leveling nuts and tighten top nuts to torque level in accordance with manufacturer's published instructions.

    a. Use anchor bolts and nuts selected to resist seismic forces specified for the application and approved by manufacturer.
    b. Grout void between lighting standard base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
    c. Install base covers unless otherwise indicated.
    d. Use a short piece of **1/2 inch** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of lighting standard.

5. Lighting Standards and Foundations Set in Concrete-Paved Areas: Install lighting standards with a minimum **6 inch** wide, unpaved gap between the lighting standard or foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level **1 inch** below top of concrete slab.
6. Raise and set lighting standard using web fabric slings (not chain or cable) at locations indicated by manufacturer.
7. Corrosion Prevention:

    a. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.
    b. Steel Conduits: Comply with requirements in Section 260533.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with **0.010 inch** thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

D. Interfaces with Other Work:

1. Grounding and Bonding: Bond metallic components of lighting standards and support structures as follows:

    a. Provide insulated equipment grounding conductors with supply feeders for bonding luminaires and other pole-mounted electrical or electronic equipment to ground terminals of their supplying power sources in accordance with Article 250 of NFPA 70.
    b. Bond metallic components of luminaires, pole accessories, and foundation to insulated equipment grounding conductor.

2. Identification: Provide labels for lighting standards, components, wiring, cabling, terminals, and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.

b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3.3 INSTALLATION OF UTILITY POLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: [**IEEE C2**][**NFPA 70 and NECA NEIS 1**].
2. Electrical Safety: NFPA 70E.
3. Hot Work: NFPA 51B.
4. Grounding and Bonding: [**IEEE C2**][**NECA NEIS 331 and Article 250 of NFPA 70**].
5. Communications Work: BICSI N1.
6. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document must also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.
2. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
3. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and in accordance with the following:

   a. On level ground, set poles so tops of consecutive poles vary not more than **60 inch** in elevation.
   b. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.

4. Set poles in accordance with the following:

   a. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
   b. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:

      1) Poles up to 35 ft (10.6 m) Long: **24 inch**.
      2) Poles 36 to 60 ft (11 to 18.3 m) Long: **30 inch**.
      3) Poles 61 to 75 ft (18.6 to 22.9 m) Long: **36 inch**.

   c. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
   d. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain **1 inch** minimum, **2 inch** maximum, (after conductors are installed at required tension) for each **10 ft** of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
   e. Backfill holes in **6 inch** maximum lifts, and thoroughly tamp each layer before starting the

next.

f. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
g. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead ends; place gains on last two poles on side facing terminal or dead end.
h. Poles Set in Concrete Paved Areas: Install poles with minimum of **6 inch** wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with [**pea gravel**]<**Insert appropriate material**> to a level **1 inch** below top of concrete slab.

5. Field treat factory-treated poles and crossarms as follows:

a. Poles Treated More Than One Year before Installation: Treat portion from **24 inch** above ground line to butt.
b. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
c. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
d. Engage the services of qualified wood pole and crossarm treatment technician to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.

6. Installation of Crossarms: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

a. Buck Arms: Install at corners and junction poles unless otherwise indicated.
b. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
c. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
d. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

7. Installation of Guys and Anchors:

a. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inch** or more. Comply with IEEE C2.

1) Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
2) At the anchor end, attach guy strand assembly with preformed grips.

b. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.
c. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio must be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.
d. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inch** from ground.
e. Install strain insulators to provide a minimum of **12 inch** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators must be loaded to not more than two-thirds of manufacturer's published rating.

8. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

D. Interfaces with Other Work:

1. Grounding and Bonding:

    a. Comply with [**IEEE C2**][**NFPA 70**] grounding and bonding requirements.
    b. Ground Rods: [**Copper-clad**][**Zinc-coated**][**Stainless**] steel[**, sectional type**]; [**3/4 inch by 10 ft**][**5/8 inch by 8 ft**].

        1) Install [**two**]<**Insert number**> parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 Ω.
        2) Drive ground rods until tops are **12 inch** below finished grade in undisturbed earth.

    c. Grounding (Earthing) Conductors:

        1) 4 AWG minimum, soft-drawn copper.
        2) Conductor Protectors for Wood Poles: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communications service and transformer spaces.
        3) Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
        4) Lightning Arrester Grounding Conductors: Separate from other grounding conductors.

    d. Bonding Conductors: Provide equipment grounding conductors with supply feeders for bonding pole-mounted electrical and electronic equipment to ground terminals of their supplying power sources in accordance with Article 250 of NFPA 70.

2. Identification: Provide labels for poles, components, wiring, cabling, terminals, and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
    d. Locate pole numbers to provide maximum visibility from the road or patrol route.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Inspect poles for nicks, mars, dents, scratches, and other damage.
2. System function tests.
3. Guy Anchors: Test one of each type and capacity installed[**, plus additional units specifically indicated for testing**]. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

    a. Acceptable Test Results: Denoted by movement of less than **3/8 inch** by the holding component of the anchor in the earth or other medium in which it is installed.
    b. Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.

4. Pole Ground Resistance: Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.

    a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
    b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground, tested individually, exceeds 25 Ω, add a ground electrode not less than **10 ft** away and interconnect with 2 AWG, minimum, bare conductor buried at least **12 inch** below furnished grade.

5. <**Insert special inspections**>.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

END OF SECTION 26 05 46 00

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Task	Specification	Specification Description
26 05 46 00	01 55 26 00a	Fabricated Control Booths
26 05 46 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 05 53 00 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Extruded insulating tubing.
3. Bands.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 284600 "Fire Detection and Alarm"[**and Section 284614 "Single- and Multiple-Station Alarms"**] specifies fire detection and alarm devices referenced in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

B. UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Champion America**]
c. [**emedco**]
d. [**Grafoplast Wire Markers**]
e. [**HellermannTyton**]
f. [**LEM Products Inc.**]
g. [**Marking Services Inc.**]
h. [**Panduit Corp**]
i. [**Seton Identification Products; a Brady Corporation company**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Champion America**]
c. [**emedco**]
d. [**Grafoplast Wire Markers**]
e. [**HellermannTyton**]
f. [**LEM Products Inc.**]
g. [**Marking Services Inc.**]
h. [**Panduit Corp**]
i. [**Seton Identification Products; a Brady Corporation company**]
j. <**Insert manufacturer's name**>

C. UL PGDQ2 - Self-Adhesive Wraparound Labels: [**Preprinted**][**Write-on**], **3 mil (0.08 mm)** thick, [**polyester**][**vinyl**] flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**Ideal Industries, Inc.**]
g. [**LEM Products Inc.**]
h. [**Marking Services Inc.**]
i. [**Panduit Corp**]
j. [**Seton Identification Products; a Brady Corporation company**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**Ideal Industries, Inc.**]
g. [**LEM Products Inc.**]
h. [**Marking Services Inc.**]
i. [**Panduit Corp**]
j. [**Seton Identification Products; a Brady Corporation company**]
k. <**Insert manufacturer's name**>

3. Self-Lamination: Clear; UV-, weather-, and chemical-resistant; self-laminating, with protective shield over legend. Size labels such that clear shield overlaps entire printed legend.
4. Marker for Labels:

a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. UL PGDQ2 - Self-Adhesive Labels: [**Polyester**][**Vinyl**], thermal, transfer-printed, **3 mil (0.08 mm)** thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**HellermannTyton**]
g. [**Ideal Industries, Inc.**]
h. [**LEM Products Inc.**]
i. [**Marking Services Inc.**]
j. [**Panduit Corp**]
k. [**Seton Identification Products; a Brady Corporation company**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A'n D Cable Products**]
b. [**Brady Corporation**]
c. [**Brother International Corporation**]
d. [**emedco**]
e. [**Grafoplast Wire Markers**]
f. [**HellermannTyton**]
g. [**Ideal Industries, Inc.**]
h. [**LEM Products Inc.**]

i. [**Marking Services Inc.**]
j. [**Panduit Corp**]
k. [**Seton Identification Products; a Brady Corporation company**]
l. <**Insert manufacturer's name**>

3. Minimum Nominal Size:

a. **1-1/2 by 6 inch (37 by 150 mm)** for raceway and conductors.
b. **3-1/2 by 5 inch (76 by 127 mm)** for equipment.
c. As required by authorities having jurisdiction.

2.2 EXTRUDED INSULATING TUBING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

B. UL YDPU2 - Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of **200 deg F (93 deg C)**.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Panduit Corp**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Panduit Corp**]
c. <**Insert manufacturer's name**>

2.3 BANDS

A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]

b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, **2 inch (50 mm)** long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**HellermannTyton**]
c. [**Marking Services Inc.**]
d. [**Panduit Corp**]
e. <**Insert manufacturer's name**>

2.4 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**HellermannTyton**]

e. [**Ideal Industries, Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**HellermannTyton**]
e. [**Ideal Industries, Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. <**Insert manufacturer's name**>

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than **3 mil (0.08 mm)** thick by **1 to 2 inch (25 to 50 mm)** wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. <**Insert manufacturer's name**>

C. Tape and Stencil: **4 inch (100 mm)** wide black stripes on **10 inch (250 mm)** centers placed diagonally over orange background and are **12 inch (300 mm)** wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HellermannTyton**]
b. [**LEM Products Inc.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]

f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**HellermannTyton**]
b. [**LEM Products Inc.**]
c. [**Marking Services Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

D. Floor Marking Tape: **2 inch (50 mm)** wide, **5 mil (0.125 mm)** pressure-sensitive vinyl tape, with [**black and white**][**yellow and black**] stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Seton Identification Products; a Brady Corporation company**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Seton Identification Products; a Brady Corporation company**]
d. <**Insert manufacturer's name**>

E. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Ideal Industries, Inc.**]
c. [**LEM Products Inc.**]
d. [**Marking Services Inc.**]
e. [**Pipemarker.com; Brimar Industries, Inc.**]
f. [**Reef Industries, Inc.**]
g. [**Seton Identification Products; a Brady Corporation company**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]

b. [**Ideal Industries, Inc.**]
c. [**LEM Products Inc.**]
d. [**Marking Services Inc.**]
e. [**Pipemarker.com; Brimar Industries, Inc.**]
f. [**Reef Industries, Inc.**]
g. [**Seton Identification Products; a Brady Corporation company**]
h. <**Insert manufacturer's name**>

3. Tape:

a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical [**and communications**]utility lines.
b. Printing on tape must be permanent and may not be damaged by burial operations.
c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

4. Color and Printing:

a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
b. Inscriptions for Red Tapes: [**"CAUTION BURIED ELECTRIC LINE BELOW"**]<**Insert inscription**>.
c. Inscriptions for Orange Tapes: [**"CAUTION BURIED CATV LINE BELOW"**][**"CAUTION BURIED TELEPHONE LINE BELOW"**][**"CAUTION BURIED FIBER OPTIC LINE BELOW"**][**"CAUTION BURIED COMMUNICATION LINE BELOW"**]<**Insert inscription**>.

5. Nonconducting Line-Warning Tape :

a. Pigmented polyolefin, bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Thickness: **4 mil (0.1 mm)**.
d. Weight: **18.5 lb/1000 sq. ft (9.0 kg/100 sq. m)**.
e. Tensile in accordance with ASTM D882: **30 lbf (133.4 N)** and **2500 psi (17.2 MPa)**.

6. Reinforced Nonconducting Line-Warning Tape :

a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Thickness: **12 mil (0.3 mm)**.
d. Weight: **36.1 lb/1000 sq. ft (17.6 kg/100 sq. m)**.
e. Tensile in accordance with ASTM D882: **400 lbf (1780 N)** and **11,500 psi (79.2 MPa)**.

7. Detectable Line-Warning Tape :

a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
b. Width: **3 inch (75 mm)**.
c. Overall Thickness: **5 mil (0.125 mm)**.
d. Foil Core Thickness: **0.35 mil (8.9 m)**.
e. Weight: **28 lb/1000 sq. ft (13.7 kg/100 sq. m)**.
f. Tensile in accordance with ASTM D882: **70 lbf (311.3 N)** and **4600 psi (31.7 MPa)**.

8. Reinforced Detectable Line-Warning Tape :

    a. Reinforced, detectable three-layer laminate, consisting of printed pigmented woven scrim, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright-colored, [**continuous-printed on one side with inscription of utility,**]compounded for direct-burial service.
    b. Width: **3 inch (75 mm)**.
    c. Overall Thickness: **8 mil (0.2 mm)**.
    d. Foil Core Thickness: **0.35 mil (8.9 m)**.
    e. Weight: **34 lb/1000 sq. ft (16.6 kg/100 sq. m)**.
    f. Tensile in accordance with ASTM D882: **300 lbf (1334 N)** and **12,500 psi (86.1 MPa)**.

F. Concrete Cable Route Markers :

1. Description: Concrete markers visually aid tracing the route of electrical cables. Monument markers are typically installed at grade. Protective cover markers are typically installed above the cables at grade or below grade.
2. Product Characteristics:

    a. Material: Precast reinforced concrete.
    b. Marker Type:

        1) Above-Ground Monument Post:

            a) Nominal Dimensions (Height, Width, Depth): **30 inch (760 mm)**, **6 inch (150 mm)**, **3 inch (75 mm)**.

        2) Above-Ground Monument Block:

            a) Nominal Dimensions (Height, Width, Depth): [**12 inch (300 mm)**, **12 inch (300 mm)**, **6 inch (150 mm)**][**24 inch (600 mm)**, **24 inch (600 mm)**, **4 inch (100 mm)**].

        3) In-Ground Protective Cover (Plank or Slab):

            a) Nominal Dimensions (Length, Width, Depth): [**36 inch (914 mm)**, **6 inch (150 mm)**, **2 inch (50 mm)**][**36 inch (914 mm)**, **9 inch (230 mm)**, **2 inch (50 mm)**][**12 inch (305 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**][**24 inch (610 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**][**36 inch (914 mm)**, **12 inch (305 mm)**, **2 inch (50 mm)**].

    c. Legend: [**"DANGER - ELECTRICITY"**][**"ELECTRIC CABLES"**][**"ELECTRIC SPLICE"**].
    d. Lettering: Approximately **1/8 inch (3 mm)** deep, not less than [**1 inch (25 mm)**][**1.5 inch (38 mm)**] high, symmetrically spaced; marked on both sides to allow for reversal.

3. Required Product Options:

    a. Color: [**Red**]<**Insert color**> dye added to concrete during batching.
    b. Attach metal medallion or sign stamped with [**feeder number**]<**Insert required information**>.

G. Stenciled Legend: In nonfading, waterproof, [**black**]<**Insert color**> ink or paint. Minimum letter height must be [**1 inch (25 mm)**]<**Insert dimension**>.

2.5 TAGS

A. Metal Tags: Brass or aluminum, **2 by 2 by 0.05 inch (50 by 50 by 1.3 mm)**, with stamped legend, punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

B. Nonmetallic Preprinted Tags: Polyethylene tags, [**0.015 inch (0.38 mm)**][**0.023 inch (0.58 mm)**] thick, color-coded for phase and voltage level, with factory [**screened**][**printed**] permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Grafoplast Wire Markers**]
e. [**LEM Products Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. [**Seton Identification Products; a Brady Corporation company**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Grafoplast Wire Markers**]

e. [**LEM Products Inc.**]
f. [**Marking Services Inc.**]
g. [**Panduit Corp**]
h. [**Seton Identification Products; a Brady Corporation company**]
i. <**Insert manufacturer's name**>

C. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**LEM Products Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**LEM Products Inc.**]
d. [**Pipemarker.com; Brimar Industries, Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

3. Polyester Tags: [**0.010 inch (0.25 mm)**][**0.015 inch (0.38 mm)**]<**Insert dimension**> thick, with corrosion-resistant grommet and cable tie for attachment.
4. Marker for Tags:

a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.6 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**Champion America**]
d. [**emedco**]
e. [**Marking Services Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Brady Corporation**]
    b. [**Carlton Industries, LP**]
    c. [**Champion America**]
    d. [**emedco**]
    e. [**Marking Services Inc.**]
    f. <**Insert manufacturer's name**>

3. Preprinted aluminum signs, [**high-intensity reflective,**]punched or drilled for fasteners, with colors, legend, and size required for application.
4. **1/4 inch (6.4 mm)** grommets in corners for mounting.
5. Nominal Size: **7 by 10 inch (180 by 250 mm)**.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Brady Corporation**]
    b. [**Champion America**]
    c. [**emedco**]
    d. [**Marking Services Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Brady Corporation**]
    b. [**Champion America**]
    c. [**emedco**]
    d. [**Marking Services Inc.**]
    e. <**Insert manufacturer's name**>

3. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with **0.0396 inch (1 mm)** galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
4. **1/4 inch (6.4 mm)** grommets in corners for mounting.
5. Nominal Size: **10 by 14 inch (250 by 360 mm)**.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Brady Corporation**]
    b. [**Carlton Industries, LP**]
    c. [**emedco**]

d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Brady Corporation**]
b. [**Carlton Industries, LP**]
c. [**emedco**]
d. [**Marking Services Inc.**]
e. [**Seton Identification Products; a Brady Corporation company**]
f. <**Insert manufacturer's name**>

3. Engraved legend.
4. Thickness:

a. For signs up to **20 sq. inch (129 sq. cm)**, minimum **1/16 inch (1.6 mm)** thick.
b. For signs larger than **20 sq. inch (129 sq. cm)**, **1/8 inch (3.2 mm)** thick.
c. Engraved legend with [**black letters on white face**][**white letters on dark gray background**]<**Insert colors**>.
d. [**Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting**][**Self-adhesive**].
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**HellermannTyton**]
2. [**Ideal Industries, Inc.**]
3. [**Marking Services Inc.**]
4. [**Panduit Corp**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**HellermannTyton**]
2. [**Ideal Industries, Inc.**]
3. [**Marking Services Inc.**]
4. [**Panduit Corp**]
5. <**Insert manufacturer's name**>

C. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.

D. UL ZODZ - General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and

Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black, except where used for color-coding.

E. UL ZODZ - UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black.

F. UL ZODZ - Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 deg F (23 deg C)** in accordance with ASTM D638: **7000 psi (48.2 MPa)**.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: **Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C)**.
5. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection[**and fire-alarm**] equipment[**, including raceways,**] must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than [**7.7 ft (2.3 m)**]<**Insert height**> above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1[**and IEEE C2**].

C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded [**service**][**feeder**][**and**][**branch-circuit**] conductors.

1. Color must be factory applied[**or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction**].
2. Colors for 208Y/120 V Circuits:

    a. Phase A: Black.

b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 240 V Circuits:

a. Phase A: Black.
b. Phase B: Red.

4. Colors for 480Y/277 V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

5. Color for Neutral (Grounded Conductor): [**White**][**or**][**gray**].
6. Color for Equipment Ground: [**Bare copper**][**Green**][**Green with yellow stripe**].
7. Color for Isolated Ground: Green with two or more yellow stripes.

D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.

E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

F. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."
4. <**Insert name**>.

G. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

H. Locations of Underground Lines: Underground-line warning tape for power and lighting.

I. Vaults, Manholes, Handholes, and Pull and Junction Boxes, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**write-on tags**][**nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation**].

J. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with **3 inch (75 mm)** high, black letters on **20 inch (500 mm)** centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at [**10 ft (3 m)**][**30 ft (9 m)**] maximum intervals.
2. Identify system voltage[**and system or service type**] with black letters on orange field.
3. Apply floor marking tape to the following finished surfaces:

a. Floor surface directly above conduits running beneath and within **12 inch (300 mm)** of floor that is in contact with earth or is framed above unexcavated space.
b. Wall surfaces directly external to raceways concealed within wall.
c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Accessible Raceways, Armored and Metal-Clad Cables, More Than 1000 V: [**Vinyl wraparound labels**][**Snap-around labels**][**Self-adhesive labels**][**Snap-around color-coding bands for raceway and cables**].

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with black letters on orange field.

L. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**vinyl wraparound labels**][**self-adhesive wraparound labels**][**snap-around labels**][**snap-around color-coding bands**][**self-adhesive vinyl tape**] to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with [**black letters on orange field**]<**Insert color scheme**>.

M. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than [**30**]<**Insert number**> A and [**120**]<**Insert number**> V to Ground: Identify with self-adhesive [**raceway labels**][**vinyl tape applied in bands**].

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.
2. Identify system voltage[**and system or service type**] with [**black letters on orange field**]<**Insert color scheme**>.

N. Conductors to Be Extended in Future: Attach [**write-on tags**][**marker tape**] to conductors[**and list source**].

O. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:

1. Panelboard designation.
2. Colon or dash.
3. Branch circuit number.

P. Workspace Indication: Apply [**floor marking tape**][**or**][**tape and stencil**] to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

Q. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: [**Self-adhesive label**][**Baked-enamel signs**][**Metal-backed butyrate signs**][**Laminated acrylic or melamine plastic sign**].
3. Outdoor Equipment: [**Laminated acrylic or melamine sign**][**Stenciled legend 4 inch (100 mm) high**].
4. Equipment to Be Labeled:

    a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels[**containing equipment designation**].
    b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of [**self-adhesive,**

engraved,][**engraved,**] laminated acrylic or melamine label.
c. Enclosures and electrical cabinets.
d. Access doors and panels for concealed electrical items.
e. Switchgear.
f. Switchboards.
g. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
h. Substations.
i. Emergency system boxes and enclosures.
j. Motor-control centers.
k. Enclosed switches.
l. Enclosed circuit breakers.
m. Enclosed controllers.
n. Variable-speed controllers.
o. Push-button stations.
p. Power-transfer equipment.
q. Contactors.
r. Remote-controlled switches, dimmer modules, and control devices.
s. Uninterruptible power supplies.
t. Battery-inverter units.
u. Battery racks.
v. Power-generating units.
w. Monitoring and control equipment.
x. <**Insert equipment**>.

R. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with [**NFPA 70E**][**and**][**Section 260573 "Power System Studies"**] requirements for arc-flash hazard warning labels.
2. Raceways and Cables Carrying Circuits at More Than 1000 V:

a. Black letters on orange field.
b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

5. <**Insert names and wording of warning signs or labels (for example, multiple services and voltages, and others**>.

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**].

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

   a. Power-transfer switches.
   b. Controls with external control power connections.
   c. <**Insert items**>.

E. Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**].

F. Emergency Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**] with white legend on red background with minimum **3/8 inch (10 mm)** high letters for emergency instructions at equipment used for [**power transfer**][**load shedding**]<**Insert emergency operations**>.

3.4 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.5 INSTALLATION

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 018116 "Facility Environmental Requirements" and Section 260010 "Supplemental Requirements for Electrical."

C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

F. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Verify identity of item before installing identification products.

H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

I. Apply identification devices to surfaces that require finish after completing finish work.

J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of **6 inch (150 mm)** where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

U. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape not less than **12 inch (300 mm)** directly above cables or raceways buried **18 inch (450 mm)** or more below grade. Use multiple tapes where width of multiple lines installed in common trench [**or concrete envelope**]exceeds **16 inch (400 mm)** overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

V. Concrete Cable Route Markers: [**As indicated on Drawings**]<**Insert Project-specific requirements**>.

W. Metal Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

X. Nonmetallic Preprinted Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

Y. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using [**general-purpose**][**UV-stabilized**][**plenum-rated**] cable ties.

Z. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

AA. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

BB. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 26 05 53 00

Task	Specification	Specification Description
26 05 53 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 83 00	26 05 13 00	Medium-Voltage Cables
26 05 83 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 05 83 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling

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SECTION 26 08 00 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical equipment connected to Normal electrical systems, including the following:

   a. Motor-control centers.
   b. Transformers.
   c. [**Primary**][**and**][**secondary**] service electrical systems.
   d. [**Distribution**][**and**][**branch-circuit**] panelboards.
   e. Lightning protection systems.
   f. Grounding systems.

2. Electrical equipment connected to Essential electrical systems that provide an alternative source of power in the absence of power from the Normal electrical system, including the following:

   a. Motor-control centers.
   b. [**Primary**][**and**][**secondary**] service electrical systems.
   c. [**Distribution**][**and**][**branch-circuit**] panelboards.
   d. Lighting protection systems.
   e. Grounding systems.
   f. Generators.
   g. UPS.

3. Controls and instrumentation, including the following:

   a. Equipment monitoring systems.
   b. Energy monitoring and control systems.
   c. Electrical metering and metering system.
   d. Demand response systems.
   e. Lighting control systems.
   f. Security systems.
   g. Fire-alarm systems.
   h. <**Insert systems**>.

4. Systems testing and verification, including [**Normal**][**and**][**Essential**] electrical systems[**, and transitions from Normal to Essential electrical systems and back**].
5. <**Insert electrical systems**>.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
3. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. BoD: Basis-of-Design Document, as defined in Section 019113 "General Commissioning Requirements."

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Construction Checklists by CxA: Draft construction checklists will be created by CxA for Contractor review.

B. Construction Checklists by Contractor: Include the following and comply with requirements in Section 019113 "General Commissioning Requirements" for construction checklists:

1. Instrumentation and control for electrical systems.
2. Instrumentation and control for lighting control systems.
3. Low-voltage power cables.
4. Control voltage power cables.
5. Electrical feeders and branch circuits.
6. Liquid-filled transformers.
7. Dry-type transformers.
8. Instrument transformers.
9. Switchgear and switchboard assemblies rated 1200 A or greater.
10. Metal-enclosed bus duct.
11. Busway.
12. Motor-control centers.
13. Low-voltage motor starters.
14. Low-voltage air circuit breakers.
15. Low-voltage insulated case circuit breakers.
16. Low-voltage network protectors.
17. Low-voltage air switches.
18. Low-voltage surge protective devices.
19. Medium-voltage power cables.
20. Medium-voltage circuit breakers.
21. Medium-voltage motor starters.
22. Medium-voltage air circuit breakers.
23. Medium-voltage vacuum circuit breakers.
24. Medium-voltage SF6 (sulfur hexafluoride) circuit breakers.
25. Medium-voltage air switches.
26. Medium-voltage surge protective devices.
27. Protective relays.
28. Metering devices.
29. Molded-case circuit breakers.
30. Low-voltage power circuit breakers.

31. Grounding systems.
32. Ground-fault protection systems.
33. Panelboards.
34. Receptacles and devices.
35. Engine generators.
36. Automatic transfer switches.
37. Variable-frequency drives.
38. AC synchronous motors and generators.
39. AC induction motors and generators.
40. DC motors and generators.
41. Battery systems.
42. Battery chargers.
43. Flooded lead-acid batteries.
44. Flooded lead-calcium batteries.
45. VRLA batteries.
46. UPS systems.
47. Power factor correction equipment, including capacitors, dry-type reactors (both shunt and current-limiting), and liquid-filled reactors (both shunt and current-limiting).
48. Lighting.
49. Vehicle charging equipment.
50. <**Insert equipment**>.

1.4 QUALITY ASSURANCE

A. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform electrical Cx work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

a. Equipment/instrument identification number.
b. Planned Cx application or use.
c. Manufacturer, make, model, and serial number.
d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation must meet the following criteria:

a. Capable of testing and measuring performance within the specified acceptance criteria.
b. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
c. Be maintained in good repair and operating condition throughout duration of use on Project.
d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

B. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

1) Instrument or tool identification number.
2) Equipment schedule designation of equipment for which the instrument or tool is required.
3) Manufacturer, make, model, and serial number.
4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
c. Electrical proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. Prepare detailed construction checklists for electrical systems, subsystems, equipment, and components. Complete and submit construction checklists.

3.2 CONSTRUCTION CHECKLIST REVIEW

A. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.

B. Return draft Construction Checklist review comments within [**10**]<**Insert number**> days of receipt.

C. When review comments have been resolved, CxA will provide final construction checklists, marked "Approved for Use, (date)."

D. Use only construction checklists, marked "Approved for Use, (date)."

3.3 GENERAL TESTING REQUIREMENTS

A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

E. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks,

control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

F. Construction Checklists: Prepare and submit detailed construction checklists for electrical systems, subsystems, equipment, and components.

1. Contributors to development of construction checklists must include, but are not limited to, the following:

a. Electrical systems and equipment installers.
b. Electrical instrumentation and controls installers.

G. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

H. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

I. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

J. Coordinate schedule with, and perform Cx activities at the direction of the CxA.

K. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying electrical systems and equipment.

L. Provide qualified testing and inspecting agency personnel in accordance with Section 260010 "Supplemental Requirements for Electrical," instrumentation, tools, and equipment to complete and document the following:

1. Performance tests.
2. Demonstration of a sample of performance tests.
3. Cx tests.
4. Cx test demonstrations.

3.4 Cx TESTS FOR ELECTRICAL SYSTEMS

A. Verification of Normal Electrical System Operation:

1. Prerequisites: Acceptance of results for construction checklists for Division 26 electrical components associated with Normal electrical system.
2. Equipment and Systems to Be Tested: Division 26 electrical equipment.
3. Test Purpose: Verify operation of Normal electrical system.
4. Test Conditions: Energize components of Normal electrical system, one at a time.
5. Acceptance Criteria: Proper operation of Normal electrical system over a [**24**][**48**]<**Insert number**>-hour period.

B. Verification of Essential Electrical System Operation:

1. Prerequisites:

a. Acceptance of results for construction checklists for Division 26 electrical components associated with Essential electrical system.
b. Completion of "Verification of Normal Electrical System Operation" tests.

2. Equipment and Systems to Be Tested: Division 26 electrical equipment.
3. Test Purpose: Verify operation of Essential electrical system.
4. Test Conditions:

a. Energize components of Normal electrical system.
b. Simulate a failure of Normal electrical system.

5. Acceptance Criteria: Transfer of power from Normal to Essential electrical system within OPR.

C. Verification of Control and Instrumentation:

1. Prerequisites: Acceptance of results for construction checklists.

a. Section 260913 "Electrical Power Monitoring and Control."
b. Section 260926 "Lighting Control Panelboards."
c. Section 260936 "Modular Dimming Controls."
d. Section 260943.16 "Addressable-Luminaire Lighting Controls."
e. Section 260943.23 "Relay-Based Lighting Controls."
f. Section 262713 "Electricity Metering."
g. Section 263533 "Power Factor Correction Equipment."

D. Test Purpose: Verify operation of control and monitoring systems for Normal and Essential electrical systems.

E. Test Conditions:

1. Energize components of Normal electrical system.
2. Test operation of equipment.

F. Acceptance Criteria: Operation of equipment according to OPR.

END OF SECTION 26 08 00 00

SECTION 26 09 00 00 - ADDRESSABLE LUMINAIRE LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bus power supply.
2. Controller/gateways.
3. User interface.
4. Lighting control system management software.
5. Luminaire switching and dimming modules.
6. Ballast switching and dimming modules.
7. Sensors.
8. Relays.
9. Manual switches and plates.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. DALI: Digital addressable lighting interface.

B. Data Bus: Two wires used to communicate with bus connected devices.

C. Device: A collective term for DALI-compliant bus connected devices, including fluorescent ballasts, incandescent luminaires, manual switches, switching relays, and similar. Sometimes also called "slave unit."

D. Group: A set of devices that respond at the same time to messages on the data bus.

E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

F. Scene: Digital light level associated with a preset; stored in the luminaire ballast.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches

and plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.

B. Shop Drawings:

1. Floor Plans: Location, orientation, and coverage area of each sensor; group designations; and other specific design symbols and designations as required to define the installation, location, and configuration of all control devices.
2. Address Drawing: Reflected ceiling plan and floor plans, showing data-bus-connected devices, address for each device, and device groups. The plans must be based on construction plans, using the same legend, symbols, and schedules.
3. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads connected to each data bus and total connected load for each data bus. Include percentage of rated connected load and device addresses.
4. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
6. Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section number and title.**>

    a. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.
    b. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Bus Power Supplies: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.
2. Controller/Gateways: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.
3. Incandescent Switching and Dimming Modules: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.
4. Fluorescent Ballasts: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.

5. Lighting Control Relays: Equal to [**two**]<**Insert number**> percent of amount installed, but no fewer than [**two**]<**Insert number**>.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Software: Failure of input and output to execute switching or dimming commands.
b. Failure of modular relays to operate under manual or software commands.
c. Ballast failure.
d. Damage of electronic components due to transient voltage surges.

2. Warranty Periods:

a. For DALI Ballasts: [**Three**]<**Insert number**> years from date of Substantial Completion.
b. For Control Components That Are Not Part of Ballasts: [**Three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. DALI:

1. Components: Individually addressable devices (such as ballasts, relays, dimmers, and switches) that are operated from digital signals received through a DALI-compliant bus, from data-entry and -retrieval devices (such as computers, Internet portals, hand-held IR programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs[**, and**]<**Insert digital communications device**>). Devices also report status to data-entry and -retrieval devices though the bus.
2. Digital Control: Use peer-to-peer communication and distributed logic, where the failure of any single component must be automatically isolated and not affect global system functions.

B. Ethernet LAN:

1. Provide an Ethernet LAN to connect controller/gateways to a PC running a Microsoft Windows operating system. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."
2. Ethernet Protocols: Comply with and be compatible with 10/100 BaseT TCP/IP routers and networks.
3. TCP/IP Modem: Capable of maintaining a secure Internet connection using VPN or equivalent protocol.

C. Interface with HVAC DDC System: Hardware and software must interface with HVAC DDC system to monitor, control, display, and record data for use in processing reports. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Hardwired Points:

a. Monitoring: On-off status, <**Insert monitoring point**>.

b. Control: On-off operation, <**Insert control point**>.

2. Communication Interface: Comply with [**ASHRAE 135**]<**Insert type of interface**>. Communication must interface with HVAC DDC system to remotely control and monitor lighting from HVAC DDC system operator workstation. Control features and monitoring points displayed locally at lighting panel must be available through DDC system for HVAC. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge protective device complying with UL 1449, SPD Type 2.

E. Operation: Input signal from digital signal sources switches or dims DALI devices associated with ballasts or luminaires, or switches field-deployed, DALI-compliant, control relays.

1. Each device and relay is connected to a digital data bus.
2. Each DALI device and relay has a digital address and can be operated by a digital signal.
3. Each device or relay can be assigned to any or all of 16 available groups connected to a single data bus.
4. Each dimming ballast may have as many as 16 preset lighting levels or scenes. Scenes can be programmed to ballasts and may be applied to groups.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

H. Comply with protocol described in IEC 60929, Annexes E and G, for DALI lighting control devices, wiring, and computer hardware and software.

I. Comply with UL 916.

2.2 BUS POWER SUPPLY

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**nLight; Acuity Brands Lighting, Inc.**]
4. [**Philips; Signify North America; Signify Holding**]
5. [**Starfield Controls, Inc.**]
6. [**Tridonic**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**nLight; Acuity Brands Lighting, Inc.**]
4. [**Philips; Signify North America; Signify Holding**]
5. [**Starfield Controls, Inc.**]
6. [**Tridonic**]

7. <**Insert manufacturer's name**>

C. Description: Supply power to data bus for 64 addressable devices, suitable for use with NFPA 70, Class 2 control circuit.

1. Primary Power: Field selectable, 120 and 277 V.
2. Power Supply: Regulated to maintain the operating voltage above 15 V(dc) under full load, and rated for full charging load of 250 mA and a minimum maintained connected load of 190 mA.
3. Pilot Lights: Indicate data bus ground-fault and data bus traffic.

2.3 CONTROLLER/GATEWAYS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**RAB Lighting**]
5. [**Starfield Controls, Inc.**]
6. [**Tridonic**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**RAB Lighting**]
5. [**Starfield Controls, Inc.**]
6. [**Tridonic**]
7. <**Insert manufacturer's name**>

C. Description: DALI controller/gateways link the distributed data buses with an Ethernet network to provide computer configuration, control, analysis, and maintenance. Controller/gateways operate independently and continue to process local inputs and schedules when disconnected from the LAN. Controller/gateways must provide local intelligence and features including the following:

1. Integrated real-time clock with automatic daylight savings adjustment and leap-year correction.
2. Integrated sunrise/sunset support based on the site location (latitude and longitude).
3. Automatic time schedules, to control groups for scheduled occupancy with support for holiday exceptions.
4. Two digital outputs for additional control and interlocking with external equipment such as fans, valves, and security panels.
5. Support [**one**][**two**] data bus(es).
6. Computer Monitoring and Configuration: The controller/gateway must allow configuration, monitoring, and analysis from PCs on the Ethernet LAN.

D. Each data bus must have the capacity to control 64 addressable devices, using NFPA 70, Class 2 control circuit.

1. Each data bus must have the capacity to control up to 16 groups and scenes.
2. 10 BaseT Ethernet port for DDC system for HVAC connection.

3. LED indicator lights for Ethernet status (link, send, and receive), power-on, and LAN failure.
4. Linking of switch and sensor inputs to relay and ballast outputs.
5. Viewing relay and ballast output status.
6. Controlling relay and ballast outputs.
7. Setting device addresses.
8. Assigning switch and sensor inputs and relay and ballast output modes.

E. Allow connection of the following DALI-compliant addressable devices:

1. Fluorescent luminaire switching and dimming, for linear and compact lamps.
2. Incandescent luminaire switching and dimming.
3. HID and HPS luminaire switching and dimming.
4. LED luminaire switching and dimming.
5. Occupancy and photoelectric sensors.
6. Emergency lighting interface complying with UL 924.

F. Stores system programming in nonvolatile memory.

1. Switch to enable or disable software programming.

2.4 USER INTERFACE

A. Workstations: A laptop PC, with Microsoft Windows operating system and lighting control system management software installed. With automatic backup.

1. Include documentation, storage media, and licensing for a minimum of five concurrent users.

B. Tablet Computer: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier. The software must provide for all DALI-protocol programming commands to be applied to the controller/gateway via a tethered connection.

C. Web Interface: Internet portal, with [**one**][**10**]<**Insert number**> unique username and password(s), and a custom graphical user interface, allowing DALI-protocol programming commands to be applied to the controller gateway via [**LAN**][**the Internet**].

D. IR Programming Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier to program the manual switches.

2.5 LIGHTING CONTROL SYSTEM MANAGEMENT SOFTWARE

A. The software must provide for programming, configuring, and monitoring all devices connected to all data buses of the lighting control system, using application-specific software with Microsoft Windows-based, user-friendly software with graphical user-interface designed screens.

1. The software must be object oriented with pop-up menus and built-in help screens. All specified features of the data-bus-connected devices and those associated with controller/gateways must be included in the software.

2.6 LUMINAIRE SWITCHING AND DIMMING MODULES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**Starfield Controls, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Lutron Electronics Co., Inc**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**Starfield Controls, Inc.**]
5. <**Insert manufacturer's name**>

C. Description: Comply with DALI exponential dimming curve calibrated for the connected lamp type, group, and scene settings, and with DALI light-level and configuration commands. Dimmer rise time must be not less than 15 microseconds.

2.7 BALLAST SWITCHING AND DIMMING MODULES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Lutron Electronics Co., Inc**]
2. [**OSRAM SYLVANIA**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**Tridonic**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Lutron Electronics Co., Inc**]
2. [**OSRAM SYLVANIA**]
3. [**Philips; Signify North America; Signify Holding**]
4. [**Tridonic**]
5. <**Insert manufacturer's name**>

C. Each ballast or group must be addressable and must include on-off, fade, dimming, scene settings, and other standard DALI control functions and as required to meet the sequence of operation.

D. Ballasts: Comply with requirements in [**Section 265116 "Fluorescent Interior Lighting" for ballasts for linear fluorescent lamps**][**and**][**Section 265123 "HID Interior Lighting" for ballasts for HID lamps**]; electronic programmed-start; and the following:

1. Starting Method: Programmed rapid start with antiflash (turns on at previously set light level).
2. Dimming Range: 100 to 10 percent of rated lumens unless otherwise indicated.
3. Ballast Factor: 1.0 at full output; 0.01 at full dim.
4. Input Voltage Range: 108 to 305 V.

2.8 SENSORS

A. Comply with requirements in Section 260923 "Lighting Control Devices." All sensors must be DALI-protocol compliant.

B. Daylight Harvesting Switching and Dimming Controls:

1. Adjustments and Set Points: All adjustments with exception of sensor range must be made via the communication network.
2. Remote Monitoring and Reporting: Sensor value must be displayed when queried by lighting management software or must automatically report based on a change of value or change of time period setting.

C. Indoor Occupancy Sensors: May be powered directly from the lighting control network or with a standalone power supply. Units powered with a standalone power supply must interface with the lighting control system through an electrically isolated digital input.

2.9 RELAYS

A. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating must be not less than 5 kA. Pilot light indicates when relay is closed and latched. Control must be by DALI digital data bus. Relay status must be displayed when queried by lighting management software.

B. Relay Panel: A single enclosure with incoming lighting branch circuits, relays, and connection to the DALI digital control network.

1. Enclosure: NEMA 250, Type 1 unless otherwise indicated.
2. Barriers to separate control-voltage and low-voltage components.
3. Directory: Cover mounted, identifying each relay with its device address and naming the load controlled.

C. Individually Mounted Relays:

1. Enclosure: Standard outlet box or NEMA 250, Type 1 unless otherwise indicated.
2. Directory: Cover mounted, identifying each relay with its device address.

2.10 MANUAL SWITCHES AND PLATES

A. Connection Type: RS-485 protocol, [**Category 5**][**Category 5e**] UTP cable, using 8PSJ connectors. Power must be from the control unit.

B. Push-Button Switches: Modular, operating over the DALI digital data bus.

1. Each switch must control the following functions, in coordination with programmed sequence of operation and related sensors:

a. On.
b. Off.
c. Dimming, increase light level.
d. Dimming, decrease light level.
e. Return to preset light level.

2. LED Pilot Lights: On to indicate that the control is active, or when the manual control is operated.
3. Match color and style specified in Section 262726 "Wiring Devices."
4. Integral IR receiver for programming.

C. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."

D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.11 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260523 "Control-Voltage Electrical Power Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 18**][**No. 22**][**No. 24**] AWG, complying with Section 260523 "Control-Voltage Electrical Power Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 14**][**No. 16**][**No. 18**] AWG, complying with Section 260523 "Control-Voltage Electrical Power Cables."

D. Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with [**Category 5e**][**Category 6**] for horizontal copper cable and with Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260523 "Control-Voltage Electrical Power Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

1. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
2. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 IDENTIFICATION

A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Identify all ceiling-mounted controls with data bus number and device address.

D. Label each device cable within **6 inch (152 mm)** of connection to bus power supply or termination block.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test continuity of each circuit.

B. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Test each bus controller using local and remote controls.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

D. Nonconforming Work:

1. Lighting controls will be considered defective if they do not pass tests and inspections.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Field Test Reports:

1. Prepare test and inspection reports, including a certified report that identifies bus controllers included and describes query results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
2. Printed list of all points created from actual queries of all addressed control points to include lamps, ballasts, manual controls, and sensors.
3. Event log verifying the performance of all devices generating event messages to include occupancy sensors, control buttons, alarm messages, and any other change of value messages.

3.4 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Activate luminaires and verify that all lamps are operating at 100 percent.
3. Burn-in fluorescent lamps at 100 percent for 100 hours.
4. Confirm correct communications wiring, initiate communications between DALI devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.
5. <**Insert startup steps if any**>.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement must include software support for [**two**]<**Insert number**> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

END OF SECTION 26 09 00 00

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SECTION 26 09 00 00A - RELAY-BASED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting control relay panels.
2. Networked lighting control panels.
3. Manual switches and cover plates.
4. Field-mounted signal sources.
5. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and cover plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.

B. Shop Drawings: For each relay panel and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than Type 1.
3. Detail wiring partition configuration, current, and voltage ratings.
4. Short-circuit current rating of relays.
5. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.

6. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.
7. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
8. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
9. Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in [**Section 230923 "Direct Digital Control (DDC) System for HVAC."**]<**Insert Section number and title.**>

    a. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.
    b. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lighting Control Relays: Equal to <**Insert number**> percent of amount installed[**for each size indicated**], but no fewer than <**Insert number**>.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panels for installation in accordance with NECA 407.

1.7 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that components of standalone multipreset modular dimming controls perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Follow-on Extended Warranty Period: [**Eight**]<**Insert number**> year(s) from date of Substantial Completion, for materials that failed because of transient voltage surges only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Sequence of Operations: Input signal from field-mounted manual switches, or digital signal sources, must open or close one or more lighting control relays in the lighting control panels. Any combination of inputs must be programmable to any number of control relays.

B. Interface with HVAC DDC System: Hardware and software must interface with HVAC DDC system to monitor, control, display, and record data for use in processing reports. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Hardwired Points:

a. Monitoring: On-off status, <**Insert monitoring point**>.
b. Control: On-off operation, <**Insert control point**>.

2. Communication Interface: Comply with [**ASHRAE 135**][**ISO/IEC 14908-1**][**"MODBUS Application Protocol Specification"**]<**Insert type of interface**>. The communication interface must enable the HVAC DDC system operator to remotely control and monitor lighting from a HVAC DDC system operator workstation. Control features and monitoring points displayed locally at lighting panel must be available through the HVAC DDC system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

C. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.

D. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

E. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

F. Comply with UL 916.

2.2 LIGHTING CONTROL RELAY PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Intermatic, Inc**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
5. [**Lutron Electronics Co., Inc**]
6. [**Philips; Signify North America; Signify Holding**]
7. [**Siemens Industry, Inc., Energy Management Division**]
8. [**Touch-Plate Technologies**]
9. [**WattStopper; Legrand North America, LLC**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Intermatic, Inc**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
5. [**Lutron Electronics Co., Inc**]
6. [**Philips; Signify North America; Signify Holding**]
7. [**Siemens Industry, Inc., Energy Management Division**]
8. [**Touch-Plate Technologies**]
9. [**WattStopper; Legrand North America, LLC**]
10. <**Insert manufacturer's name**>

C. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.

D. Lighting Control Panel:

1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
2. A vertical barrier separating branch circuits from control wiring.

E. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.

1. Timing Unit:

a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
c. [**Four**]<**Insert number**> independent schedules, each having [**24**]<**Insert number**> time periods.
d. Schedule periods settable to the minute.
e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
f. [**10**]<**Insert number**> special date periods.

2. Sequencing Control with Override:

a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
b. Sequencing control must operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
c. Override control must allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
d. Override control "blink warning" must warn occupants approximately [**five minutes**]<**Insert time**> before actuating the off sequence.

3. Nonvolatile memory must retain all setup configurations. After a power failure, the controller must automatically reboot and return to normal system operation, including accurate time of day and date.

F. Relays:

1. Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating must be not less than 5 kA. Control must be three-wire, 24 V(ac).
2. Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V for tungsten, 30 A at 277 V for ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating must be not

less than 14 kA. Control must be three-wire, 24 V(ac).

G. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, control-voltage inputs, field-installed occupancy sensors, and photo sensors.

H. Operator Interface:

1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
2. Log and display relay on-time.
3. Connect relays to one or more time and sequencing schemes.

2.3 NETWORKED LIGHTING CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Intermatic, Inc**]
3. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
4. [**Lutron Electronics Co., Inc**]
5. [**Touch-Plate Technologies**]
6. [**WattStopper; Legrand North America, LLC**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Intermatic, Inc**]
3. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
4. [**Lutron Electronics Co., Inc**]
5. [**Touch-Plate Technologies**]
6. [**WattStopper; Legrand North America, LLC**]
7. <**Insert manufacturer's name**>

C. Description: Lighting control panels using mechanically latched relays to control lighting and appliances. The panels must be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.

D. Lighting Control Panels:

1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
2. A vertical barrier separating branch circuits from control wiring.

E. Main Control Unit: Installed in the main lighting control panel only; powered from the branch circuit of the standard control unit.

1. Ethernet Communications: Comply with [**TCP/IP**]<**Insert network protocol**> protocol. The main control unit must provide for programming of all control functions of the main and all networked slave lighting control panels including timing, sequencing, and overriding.

2. Protocol: Controllers must support serial MS/TP and Ethernet IP communications in accordance with [**ASHRAE 135**][**ISO/IEC 14908-1**][**"MODBUS Application Protocol Specification"**], and must be able to communicate directly via DDC system for HVAC TIA-485 serial networks and Ethernet 10Base-T networks as a native device.
3. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.

    a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
    b. Panel summary showing the master and slave panels connected to the controller.
    c. Controller diagnostic information.
    d. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens must also allow direct breaker control and zone overrides.

4. Timing Unit:

    a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
    b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
    c. [**Four**]<**Insert number**> independent schedules, each having [**24**]<**Insert number**> time periods.
    d. Schedule periods settable to the minute.
    e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
    f. [**16**]<**Insert number**> special date periods.

5. Time Synchronization: The timing unit must be updated not less than every <**Insert number**> hour(s) with the network time server.
6. Sequencing Control with Override:

    a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
    b. Sequencing control must operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
    c. Override control must allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
    d. Override control "blinking warning" must warn occupants approximately [**five minutes**]<**Insert time**> before actuating the off sequence.
    e. Activity log, storing previous relay operation, including the time and cause of the change of status.
    f. Download firmware to the latest version offered by manufacturer.

F. Standard Control Unit, Installed in All Lighting Control Panels: Contain electronic controls for programming the operation of the relays in the control panel, contain the status of relays, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.

1. Electronic control for operating and monitoring individual relays, and display relay on-time.
2. Nonvolatile memory must retain all setup configurations. After a power failure, the controller must automatically reboot and return to normal system operation.
3. Integral keypad and digital-display front panel for local setup, including the following:

    a. Blink notice, time adjustable from software.
    b. Ability to log and display relay on-time.
    c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.

G. Relays:

1. Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating must be not less than 5 kA. Control must be [**three-wire, 24 V(ac)**][**digital control network**].
2. Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V for tungsten, 30 A at 277 V for ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating must be not less than 14 kA. Control must be [**three-wire, 24 V(ac)**][**digital control network**].

H. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, control-voltage inputs, field-installed occupancy sensors, and control-voltage photo sensors.

I. Operator Interface: At the main control unit, provide interface for a tethered connection of [**a portable PC running MS Windows**]<**Insert digital device and operating system**> for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Owner's personnel. That device must remain the property of Owner.

J. Software:

1. Menu-driven data entry.
2. Online and offline programming and editing.
3. Provide for entry of the room or space designation for the load side of each relay.
4. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.
5. Size the software appropriate to the system.

2.4 MANUAL SWITCHES AND COVER PLATES

A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.

1. Match color and style specified in Section 262726 "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Cover Plates: Single and multigang cover plates as specified in Section 262726 "Wiring Devices."

C. Legend: Engraved or permanently silk-screened on cover plate where indicated. Use designations indicated on Drawings.

2.5 FIELD-MOUNTED SIGNAL SOURCES

A. Daylight Harvesting Switching Controls: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal must be compatible with the relays.

B. Indoor Occupancy Sensors and Extreme-Temperature Occupancy Sensors: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal must be compatible with the relays.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 18**][**No. 22**][**No. 24**] AWG. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 14**][**No. 16**][**No. 18**] AWG. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

D. Twisted-Pair Data Cable: [**Category 5e**][**Category 6**][**Category 6a**].

1. Comply with requirements for twisted pair cabling in Section 260523 "Control-Voltage Electrical Power Cables."
2. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels in accordance with NECA 407.

B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING

A. Wiring Methods:

1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters.
2. Install cables in raceways and cable trays except within consoles, cabinets, desks, counters, accessible ceiling spaces, and gypsum board partitions where unenclosed wiring method may be used.
3. Install conductors and cables concealed in accessible ceilings, walls, and floors where possible.
4. Conceal raceway and cables except in unfinished spaces.
5. Provide plenum-rated cable, where installed exposed or in open cable tray, within environmental airspaces, including plenum ceilings.
6. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
7. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and

without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 INSTALLATION OF PANELS

A. Install panels and accessories in accordance with NECA 407.

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Mount top of trim [**90 inch (2286 mm)**]<**Insert dimension**> above finished floor unless otherwise indicated.

D. Mount panel cabinet plumb and rigid without distortion of box.

E. Install filler plates in unused spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers described below[**and low-voltage surge arrestors**]. Certify compliance with manufacturer's test parameters.

a. Circuit-Breaker Tests:

1) Compare nameplate with Drawings and Specifications.
2) Inspect physical and mechanical conditions.
3) Inspect anchorage and alignment.
4) Verify that the units are clean.
5) Operate the circuit breaker to ensure smooth operation.
6) Inspect bolted electrical connections for high resistance using one or more of the following methods:

a) A low-resistance ohmmeter.
b) Verify tightness of bolted electrical connections by calibrated torque wrench.
c) Thermographic survey.

7) Inspect operating mechanism, contacts, and arc chutes in unsealed units.
8) Perform adjustments for final protective device settings in accordance with the overcurrent protective device coordination study. Comply with requirements in Section 260573.16 "Coordination Studies."
9) Perform insulation resistance tests for one minute on each pole, phase-to-phase, and phase-to-ground with the circuit breaker closed and across each pole using manufacturer's published data.
10) Perform a contact/pole-resistance test.
11) Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be for one minute. Follow manufacturer's instructions for solid-state units.
12) Determine long-time pickup and delay by primary current injection.
13) Determine short-time pickup and delay by primary current injection.
14) Determine ground-fault pickup and time delay by primary current injection.
15) Determine instantaneous pickup by primary current injection.
16) Test functions of the trip unit by means of secondary injection.
17) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
18) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset trip logs and indicators.
19) Verify operation of charging mechanism.

b. Surge Arrestor Tests:

1) Compare nameplate with the Contract Documents.
2) Inspect physical and mechanical conditions.
3) Inspect anchorage, alignment, grounding, and clearances.
4) Verify that the units are clean.
5) Inspect bolted electrical connections for high resistance using one or more of the following methods:

a) Low-resistance ohmmeter.
b) Verify tightness of bolted electrical connections by calibrated torque wrench.

6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
7) Perform an insulation-resistance test on each arrestor, phase terminal-to-ground using voltage in accordance with manufacturer instructions.
8) Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding tests.

C. Nonconforming Work:

1. Lighting control panel will be considered defective if it does not pass tests and inspections.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and

observations made after remedial action.

E. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.6 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's instructions.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system in accordance with approved configuration schedules, time-of-day schedules, and input override assignments.
3. <**Insert startup steps if any**>.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION 26 09 00 00A

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Task	Specification	Specification Description
26 09 13 00	26 09 00 00	Addressable Luminaire Lighting Controls
26 09 13 00	26 09 00 00a	Relay-Based Lighting Controls

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SECTION 26 09 23 00 - ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multifunction energy meters.
2. Power meters.
3. Circuit meters and monitors.
4. Circuit meter and explorer.
5. PC operating system software.
6. Networked PC operating system software.
7. Power monitoring and control software.
8. Network configuration software.
9. Monitoring and control of power distribution equipment.
10. System operator interfaces.
11. Desktop workstations.
12. Portable workstations.
13. Raceways and boxes.
14. Wires and cables.
15. Surge protection devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 230923.13 "Energy Meters" for electricity meters for HVAC equipment.
4. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.

1.2 DEFINITIONS

A. Active Power: The average power consumed by a unit. Also known as "real power."

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. Apparent (Phasor) Power: "S = VI" where "S" is the apparent power, "V" is the RMS value of the voltage, and "I" is the RMS value of the current.

D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

G. L-G: Line to ground.

H. L-L: Line to line.

I. L-N: Line to neutral.

J. MODBUS TCP/IP: An open protocol for exchange of process data.

K. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

L. N-G: Neutral to ground.

M. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Multifunction energy meters.
2. Power meters.
3. Circuit meters and monitors.
4. Circuit meter and explorer.
5. PC operating system software.
6. Networked PC operating system software.
7. Power monitoring and control software.
8. Network configuration software.
9. Monitoring and control of power distribution equipment.
10. System operator interfaces.
11. Desktop workstations.
12. Portable workstations.
13. Raceways and boxes.
14. Wires and cables.
15. Surge protection devices.

B. Sustainable Design Submittals:

1. Product Data: Indicating that computers used by the system are certified by ENERGY STAR.

C. Shop Drawings: For power monitoring and control equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.

a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:

1) Location of the meters and gateways, and routing of the connecting wiring.

2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Network naming and numbering scheme.
5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
6. Specifications for workstations.
7. UPS sizing calculations for workstation.
8. Surge Suppressors: Data for each device used and where applied.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to do the following:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

m. Owner training materials.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Addressable Relays: One for every [**10**]<**Insert number**> installed. Furnish at least one of each type.
2. Data Line Surge Suppressors: One for every [**10**]<**Insert number**> of each type installed. Furnish at least one of each type.
3. <**Insert material**>.

1.6 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:

1. Electrical meters that monitor, control, and connect to the data transmission network.
2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.
3. Include [**PC-based workstation**][**multiple PC-based workstations**][**with web access**], with its operating system and application software, connected to data transmission network.

B. The electrical power monitoring and control system must be Internet based.

1. System software must be based on server thin-client architecture, designed around open standards of internet technology.
2. Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser must be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
3. Internet access must be password protected.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with UL 61010-1 and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Power Lines 120 V and More: [**SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction.**][**Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."**]
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

B. Addressable Devices: Transmitters and receivers must communicate unique device identification and status reports to monitoring and control clients.

C. Interface with DDC System for HVAC: Provide factory-installed hardware and software to enable the DDC system for HVAC to monitor, display, and record data for use in processing reports.

1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours)[**, power factor**]<**Insert monitoring point**>.
2. [**ASHRAE 135 (BACnet)**][**ISO/IEC 14908-1 (LonTalk)**][**MODBUS Application Protocol Specification**][**Industry-accepted, open-protocol**]<**Insert type of interface**> communication interface with the DDC system for HVAC must enable the DDC system for HVAC operator to remotely monitor meter information from a DDC system for HVAC workstation. Control features and monitoring points displayed locally at metering panel must be available through the DDC system for HVAC.

D. Backup Power Source:

1. Electrical power distribution equipment served by a backup power source for controls must have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 MULTIFUNCTION ENERGY METERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. <**Insert manufacturer's name**>

C. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

D. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

E. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

F. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power Factor: 1.0 percent.
4. Frequency: 0.1 percent.
5. THD: 1.0 percent.
6. Waveform Sampling: 64 per cycle.

G. Data Link:

1. MODBUS TIA-485, RTU protocol, [**2**][**4**]-wire connection to host devices with a compatible port.
2. <**Insert protocol**>.

H. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values:

a. One screen to show at least [**three**]<**Insert number**> user-selected values displayed at the same time. Selections available to display must include the following:

1) Meters.
2) Measurements.
3) THD.
4) Energy.
5) Demand.
6) Minimum and maximum values.
7) Power demand.

I. Sampling Rate: Continuously sample and record voltage and current at a rate not less than [**64**]<**Insert number**> samples per cycle, simultaneously on voltage and current channels of the meter.

J. Meters:

1. Instantaneous, RMS:

a. Current: Each phase, [**neutral**]and three-phase average.
b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
c. Active Power (kW): [**Each phase and**]three-phase total.
d. Reactive Power (kVAR): [**Each phase and**]three-phase total.

e. Apparent Power (kVA): [**Each phase and**]three-phase total.
f. Power Factor: [**Each phase and**]three-phase total.

2. Energy:

a. Active Energy (kWh): Three-phase total.

3. Demand, Derived from Instantaneous RMS Meters:

a. Current: Present and maximum.
b. Active: Present and maximum.
c. Reactive: Present and maximum.
d. Apparent: Present and maximum.

4. Power Quality Measurements:

a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

K. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics must be 150 mA at 200 V.

1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:

a. User-defined pulse output, associated with kWh.
b. User-defined pulse output, associated with kVARh.

2. <**Insert control function**>.

L. Capacities and Characteristics:

1. Power Supply: [**120 V(ac), 60 Hz**]<**Insert text**>.
2. Circuit Connections:

a. Voltage: Measurement autoranging, 60 to 400 V(ac) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument grade potential transformers secondary at 120 V.**] Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 POWER METERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]

3. [**Leviton Manufacturing Co., Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. [**Siemens Industry, Inc., Energy Management Division**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Leviton Manufacturing Co., Inc.**]
4. [**Schneider Electric USA, Inc.**]
5. [**Siemens Industry, Inc., Energy Management Division**]
6. <**Insert manufacturer's name**>

C. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

D. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

E. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

F. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power: 0.6 percent.
4. Power Factor: 0.5 percent.
5. Active Energy: 0.6 percent.
6. Reactive Energy: 2.5 percent.
7. Frequency: 0.05 percent.
8. THD: 1.0 percent.
9. Waveform Sampling: 32 per cycle.

G. Data Link:

1. MODBUS TIA-485 RTU protocol, [**2**][**4**]-wire connection.

    a. Provide for firmware and software updates through the communications port.

2. <**Insert protocol**>.

H. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**]<**Insert number**> lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display must include the following:

a. Meters, including those listed under the following:

1) Measurements.
2) THD.
3) Energy.
4) Demand.
5) Minimum and maximum values.
6) Power demand.

I. Sampling Rate: Continuously sample and record voltage and current at a rate not less than [**32 samples per cycle**]<**Insert number**>, simultaneously on voltage and current channels of the meter.

J. Meters:

1. Measurements: Instantaneous, in real time, RMS to the 15th harmonic.

a. Voltage: L-L each phase, L-N each phase, and three-phase average.
b. Current: Each phase, three-phase average, and neutral.
c. Unbalanced current, L-L V(ac) and L-N V(ac).
d. Active Power (+/- kW): Each phase and three-phase total.
e. Reactive Power (+/- kVAR): Each phase and three-phase total.
f. Apparent Power (+/- kVA): Each phase and three-phase total.
g. Displacement Power Factor: Each phase and three-phase total.
h. Distortion Power Factor: Each phase and three-phase total.
i. Frequency.

2. THD from measurements simultaneously from the same cycle, through [**15th**]<**Insert number**> harmonic.

a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
b. Current THD: Each phase and three-phase average.
c. Total demand distortion.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand: Present, last, predicted, peak.

a. Three-phase average current.
b. Three-phase total active power (kW).
c. Reactive power (kVAR).
d. Apparent power (kVA).

5. Minimum and Maximum Values:

a. L-L and L-N voltages.
b. Current in each phase.
c. Power factor.
d. Active power total.
e. Reactive power total.
f. Apparent power total.
g. THD L-L and L-N voltages.

h. THD current in each phase.
i. Frequency.

K. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

    a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
    b. Fixed block that calculates demand at end of the interval.
    c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

    a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation must be configurable as either a block or rolling block calculation.
    b. Signal is a communication signal. Calculation must be configurable as either a block or rolling block calculation.
    c. Provide for synchronizing the demand with the internal of this instrument.

L. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Minimum and maximum of real-time RMS measurement.
2. Energy.
3. Demand values.
4. Alarms, store the last 40 events.

M. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than [**15**]<**Insert number**> metered items. Each alarm must be user configured, by using the following options:

1. Date and time stamp.
2. Enable-disable (default) or enable.
3. Pickup magnitude.
4. Pickup time delay.
5. Dropout magnitude.
6. Dropout time delay.
7. Alarm type.
8. Alarm label.

N. Output Signals: Provide two mechanical relays, rated not less than 250 V(ac), 2 A resistive, and rated for 200,000 cycles or more. The relays must be user configurable in one of the following listed modes:

1. Normal contact closure where the contacts change state for as long as the signal exists.
2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

O. Meter Face:

1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**]<**Insert number**> user-selected values on one screen at the same time.
3. Provide for the reset of metered peak values.

P. Capacities and Characteristics:

1. Power Supply: [**120 V(ac), 60 Hz**]<**Insert text**>.
2. Circuit Connections:

a. Voltage: Measurements autoranging, 60 to 400 V(ac) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument grade potential transformers secondary at 120 V.**] Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.5 CIRCUIT METERS AND MONITORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. <**Insert manufacturer's name**>

C. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.

1. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

D. Comply with IEC 60529 degree of protection code of IP52 for the front of the meter, and code of IP30 for the back.

E. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

F. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. For Voltage and Current: 0.5 percent of reading.
3. For Active Power: 0.2 percent.
4. For Active and Reactive Energy: ANSI 12.20, Class 0.2.
5. For Frequency: 0.01 Hz in the range of 45 to 65 Hz.
6. For Power Factor: 0.2 percent from 0.5 leading to 0.5 lagging.

G. Data Links:

1. MODBUS TIA-485 RTU protocol, [**2**][**4**]-wire connection.
2. MODBUS TIA-232/TIA-485 RTU/ASCII protocol, [**2**][**4**]-wire connection.
3. MODBUS TCP:

    a. 10/100BaseTX balanced twisted pair cabling. 8PSJ connector, 100 m link.
    b. Optical fiber 100BaseFX, LC duplex connector, 1300 m link. Multimode 62.5/125 microsecond, 2000 m link.

4. Provide for firmware and software updates through the communications port.
5. Ethernet 10/100BaseTX balanced twisted pair cabling and MODBUS TIA-485 serial master port.
6. Ethernet 10/100BaseTX balanced twisted pair cabling and MODBUS TIA-485 serial master port, Ethernet to serial line gateway, and embedded web server.
7. <**Insert protocol**>.

H. Meter Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**]<**Insert number**> lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

I. Sampling Rate:

1. Continuously sample and record voltage and current at a rate not less than [**128 samples per cycle**]<**Insert number**>, simultaneously on voltage and current channels of the meter.

J. Meters must measure, record with time stamp, calculate, and on request display the following:

1. Measurements: Instantaneous, in real time, RMS to the [**31st**][**63rd**] harmonic:

    a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
    b. Current: Each phase, three-phase average, and neutral.
    c. Active Power (kW): Each phase and three-phase total.
    d. Reactive Power (kVAR): Each phase and three-phase total.
    e. Apparent Power (kVA): Each phase and three-phase total.
    f. Displacement Power Factor: Each phase and three-phase total.
    g. Distortion Power Factor: Each phase and three-phase total.
    h. Frequency.

2. THD from measurements simultaneously from the same cycle, through [**31st**][**63rd**]<**insert number**> harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Current: Each phase, three-phase average, and neutral.

3. Energy: Accumulated, indicate in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand: Three-phase totals, present, predicted, peak.

a. Average current.
b. Active power (kW).
c. Reactive power (kVAR).
d. Apparent power (kVA).

5. Average, Minimum and Maximum Values:

a. Record, date and time stamp, and save the minimum and maximum values of RMS metered values since the last reset.
b. <**Insert values**>.

K. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation must be configurable as either a block or rolling block calculation.
b. Synchronize demand with receipt of a communication signal. Calculation must be configurable as either a block or rolling block calculation.
c. Provide for synchronization to the clock in the instrument.

L. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters.

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:

a. Every second for one minute for the one-minute curve.
b. Every minute for one hour for the one-hour curve.
c. Every hour for one day for the one-day curve.

d. Every day for one month for the one-month curve.

2. Forecast the trended parameters for the following:

a. The next four hours.
b. The next four days.

M. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated.

a. Capture, record with time stamp, and store voltage and current waveforms for two cycles.
b. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard must be user configurable.
c. Harmonic analysis performed on the captured waveforms must resolve harmonics through the 63rd.
d. Captured waveforms must be recorded from actual circuit performance.

2. Disturbance Waveform Capture:

a. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The waveform captures must be user configurable from 185 cycles on 1 channel at 16 points per cycle, to 3 cycles on 6 channels at 128 points per cycle.

N. Disturbance Detection and Alarm:

1. Detect and initiate alarm when detecting voltage or current sag and swell.

a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating RMS magnitude of each half-cycle.
b. Event detection must be with user-defined parameters of threshold and delay. The threshold must be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument must automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
c. When detecting an alarm condition:

1) Initiate disturbance waveform capture.
2) Record the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
3) Alarm on must be visible on the display and be transmitted over the data link.
4) Display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

O. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
2. The current and voltage information for phases must be obtained simultaneously from the same cycle.
3. Report harmonic information as a percentage of the fundamental or as a percentage of the RMS

values, as selected by the user.

P. Alarms: Alarm events must be user definable. Provide a minimum of 40 user-defined alarm conditions.

1. User Configuration Options:

   a. Date and time stamp.
   b. Enable-disable (default) or enable.
   c. Pickup magnitude.
   d. Pickup time delay.
   e. Dropout magnitude.
   f. Dropout time delay.
   g. Alarm type.
   h. Alarm label.

2. The following classes of events must be available to be programmed as alarm events:

   a. Over/under current.
   b. Over/undervoltage.
   c. Current imbalance.
   d. Phase loss, current.
   e. Phase loss, voltage.
   f. Voltage imbalance.
   g. Over kVA.
   h. Over kW or kVAR into/out of load.
   i. Over/under frequency.
   j. Under power factor, true or displacement.
   k. Over THD.
   l. Over demand, current or power.
   m. Reverse power.
   n. Phase reversal.
   o. Status input change.
   p. End of incremental energy interval.
   q. End of demand interval.
   r. Over/under analog inputs.
   s. Current sag/swell.
   t. Voltage sag/swell.

3. For each over/under metered alarm value, provide for the user to define a pickup, dropout, and delay.
4. The circuit meter and monitor alarms response time must be not less than one second.
5. Provide for up to four alarms to be combined to give a single result using Boolean algebra operations.

Q. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

R. I/O Module: Modular, with multiple I/O options to accomplish specified performance and one or more spare positions for future.

1. KY Pulse: Generate a standard KY pulses for a user-defined increment of metered active energy as follows:

   a. User-defined pulse output, associated with kWh.
   b. Alarm pulse output, which turns on the pulsing at user-defined point.

2. Digital Inputs: As follows:

    a. One input connection rated 24 to 125 V(ac) or V(dc), +/- 10 percent, less than 5 mA burden, 1350 V RMS isolation.
    b. Six input connections rated 19 to 30 V(dc), 5 mA maximum at 24 V(dc). Provide an onboard 24 V(dc) power supply.
    c. Two input connections rated 20 to 150 V(dc) or V(ac), 2 mA maximum.

3. Analog inputs, no fewer than two, adjustable from zero to 5 V(dc) or 4 to 20 mA.
4. Outputs to operate field-installed relays, no fewer than two, providing 6 to 240 V(ac) or 6 to 30 V(dc), 2 A RMS. 5 A maximum for 10 seconds per hour.
5. Analog outputs, no fewer than two, 4 to 20 mA(dc) into 600 ohms maximum.

S. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

    a. Each log entry must hold data of up to 96 parameters each.
    b. Each log must be user configurable to log data at a different user-defined schedule interval.
    c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
    d. Configure log entries to be recorded as Fill & Hold or Circular (First in, First out, or FIFO), as defined by the user.

2. Minimum/Maximum Logs:

    a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
    b. Minimum/Maximum log must include the time, date, and value for the minimum and maximum of each of the real-time metered values.

3. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. Record selected parameters at 100 ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
4. Waveform Logs: Capture and store waveforms, from 185 cycles on one channel at 16 samples per cycle, up to 3 cycles on six channels at 128 samples per cycle as defined by the user. Waveform log entries must be externally triggered or forced in response to a user-defined event. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

T. Capacities and Characteristics:

1. Power Supply: [**120 V(ac), 60 Hz**]<**Insert text**>.
2. Circuit Connections:

    a. Voltage: Measurement autoranging, zero to 600 V(ac) L-L, zero to 347 V(ac) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument grade potential transformers secondary at 120 V.**] Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
    b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds

once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.6 CIRCUIT METER AND EXPLORER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Schneider Electric USA, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. <**Insert manufacturer's name**>

C. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring, control, and power quality explorer; complying with UL 61010-1.

1. Provide for metering four-wire wye, three-wire wye, and three-wire delta power systems.
2. Equip the instrument with security lock to protect revenue related metering from unauthorized and accidental changes.

D. Comply with IEC 60529 degree of protection code of IP52.

E. The circuit meter and monitor must meet UL 61010-1 overvoltage withstand rating of CAT IV.

F. Accuracy to the following plus/minus values:

1. Voltage and Current Meter: 0.04 percent of reading plus 0.025 percent of full scale.
2. Power and Energy Meter: 0.075 percent of reading plus 0.025 percent of full scale.
3. Energy Meter: Comply with ANSI C12.20, Class 0.20.
4. Frequency Meter: 0.01 Hz in the range of 45 to 67 Hz and accurate to 0.1 Hz in the range of 350 to 450 Hz.
5. Power Factor: 0.002 from 0.5 leading to 0.5 lagging.

G. Data Links:

1. TIA-232 port.
2. MODBUS TIA-485 RTU protocol, [**2**][**4**]-wire connection.
3. MODBUS Ethernet TCP/IP protocol:

a. 10/100BaseTX balanced twisted pair cabling. 8PSJ connector, 100 m link.
b. Optical fiber 100BaseFX, LC duplex connector, 1300 m link. Multimode 62.5/125 microsecond, 2000 m link.

c. HTML server, with standard home page and five customizable pages.

4. Firmware and software updates must be accessible through the communications port.
5. <**Insert protocol**>.

H. Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**]<**Insert number**> lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

I. Sampling Rate:

1. Sample current and voltage to provide RMS accuracy to 255th harmonic of the fundamental frequency of 60 Hz.
2. Continuously sample and record voltage and current at a rate not less than [**512 samples per cycle**][**83,333 points per cycle**]<**Insert rate**>, simultaneously on voltage and current channels of the meter.

J. Measure, record with time stamp, and calculate; and, on request, display the following:

1. Measurements: Instantaneous, in real time, RMS to the 63rd harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, L-N three-phase average, and percent unbalanced.
b. Current: Each phase, neutral, ground, three-phase average, apparent RMS, and percent unbalanced.
c. Active Power (kW): Each phase and three-phase total.
d. Reactive Power (kVAR): Each phase and three-phase total.
e. Apparent Power (kVA): Each phase and three-phase total.
f. Displacement Power Factor: Each phase and three-phase total.
g. Distortion Power Factor: Each phase and three-phase total.
h. Frequency.
i. K-factor for each phase.

2. THD from measurements simultaneously from the same cycle, through [**255th**]<**Insert number**> harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Current: Each phase, three-phase average, and neutral.
c. Power: Active, reactive, and apparent power including power of up to [**41st**]<**Insert number**>.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand:

   a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.

      1) Present.
      2) Running average.
      3) Last completed interval.
      4) Peak.

   b. Current: Each phase, three-phase average, and neutral.

      1) Present.
      2) Last completed interval.
      3) Minimum.
      4) Peak.

   c. Active Power (kW): Three-phase totals.

      1) Last completed interval.
      2) Predicted.
      3) Peak.
      4) Coincident with peak kVA demand.
      5) Coincident with peal kVAR demand.

   d. Reactive Power (kVAR): Three-phase totals.

      1) Last completed interval.
      2) Predicted.
      3) Peak.
      4) Coincident with peak kW demand.
      5) Coincident with peal kVA demand.

   e. Apparent Power (kVA): Three-phase totals.

      1) Last completed interval.
      2) Predicted.
      3) Peak.
      4) Coincident with peak kW demand.
      5) Coincident with peak kVA demand.

   f. Distortion Power Factor: Three-phase totals.

      1) Last completed interval.
      2) Predicted.
      3) Peak.
      4) Coincident with peak kVA demand.
      5) Coincident with peal kVAR demand.

K. Average, Minimum and Maximum Values:

   1. Record, date and time stamp, and save the minimum and maximum values of RMS metered values since the last reset.
   2. Record, date and time stamp, and save maximum, minimum and average over a user-defined interval for the following metered values:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Voltage Unbalance: L-L each phase and L-N each phase.
c. Current:

1) RMS each phase, three-phase average, and calculated neutral current.
2) Apparent, RMS average.
3) Active Power (kW): Each phase and three-phase total.

d. Demand Current: RMS each phase and three-phase average.
e. Reactive Power (kVAR): Each phase and three-phase total.
f. Apparent Power (kVA): Each phase and three-phase total.
g. Demand Active Power: Each phase and three-phase total.
h. Demand Reactive Power: Each phase and three-phase total.
i. Demand Apparent Power: Each phase and three-phase total.
j. Accumulated Energy: MWh, MVAh, and MVARh.
k. Reactive energy (MVARh) by quadrant.
l. Power Factor: Three-phase displacement and distortion power factors.
m. K-factor for each phase.
n. THD L-L and L-N voltages.
o. THD current in each phase and neutral.
p. Frequency.

L. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes. The default setting must be the 15-minute continuous sliding block.
b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a synchronization signal. Synchronize demand with clock in the circuit meter and monitor.

a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation must be configurable as either a block or rolling block calculation.
b. Synchronize demand with receipt of a communication signal. Calculation must be configurable as either a block or rolling block calculation.
c. Provide for synchronization to the clock in the instrument.

4. Record, date and time stamp, and save the following demand values of RMS metered values since the last reset, including the following:

a. Average demand current, per phase.
b. Peak demand current, per phase.
c. Average demand for active power, reactive power, and apparent power.
d. Predicted demand for active power, reactive power, and apparent power.

e. Peak demand for active power, reactive power, and apparent power.

M. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters:

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:

a. Every second for one minute for the one-minute curve.
b. Every minute for one hour for the one-hour curve.
c. Every hour for one day for the one-day curve.
d. Every day for one month for the one-month curve.

2. Forecast the trended parameters for the following:

a. The next four hours.
b. The next four days.

N. Power Analysis Values:

1. THD Voltage: L-L each phase, L-N each phase, and L-N three-phase average.
2. THD Current: Each phase, three-phase average, and neutral current.
3. Total demand distortion.
4. K-factor for each phase.
5. Crest factor, each phase.
6. Displacement power factor.
7. Fundamental voltage, magnitude and angle, each phase.
8. Fundamental currents, magnitude and angle, each phase.
9. Fundamental active power, each phase and three-phase total.
10. Fundamental reactive power, each phase and three-phase total.
11. Harmonic power, each phase and three-phase total.
12. Phase rotation.
13. Voltage and current unbalances.
14. Harmonic magnitudes and angles, each phase.
15. Distortion power.
16. Distortion power factor.

O. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated over the communications network.

a. Capture, record with time stamp, and store voltage and current waveforms at a user-defined resolution of 16 to 512 samples/cycle for up to 30 seconds.
b. Capture, record with time stamp, and store 512 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard must be user configurable.
c. Harmonic analysis performed on the captured waveforms must resolve harmonics through the 255th for the following:

1) Voltage: L-N and L-G each phase.
2) Current: Of each phase and neutral current.

d. Captured waveforms must be recorded from actual circuit performance.

2. Disturbance Waveform Capture:

a. Capture, record with time stamp, and store digitally sampled data points for each cycle of

each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The captured waveform must be at a user-defined resolution of 16 to 512 samples/cycle per second. The number of pre-alarm cycles must be adjustable.

3. Waveform samples must be available for transmission over the communications network, for display, archival, and analysis at computer workstations.

P. Transient Detection:

1. Detect and capture transient voltage surge events up to 10 kV L-L with a duration as short as 200 ns.

Q. Flicker Detection:

1. Detect and capture flicker events, defined by IEEE 1453, at three levels: instantaneous, short term, and long term.
2. Display the flicker event as plots of magnitude versus time on semi-log graph background.

R. Sag and Swell Detection and Alarm:

1. Detect and initiate alarm when detecting voltage or current sag and swell.

    a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating RMS magnitude of each half-cycle.
    b. Event detection must be with user-defined parameters of threshold and delay. The threshold must be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument must automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
    c. When detecting an alarm condition:

        1) Initiate disturbance waveform capture.
        2) Initiate 100 ms event recording.
        3) Recording the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
        4) Causing an alarm on the display and transmit the alarm over the data link.
        5) The user must have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

S. 100 ms Event Recording: Capture, record with time stamp, and store.

1. Initiate recording by an alarm or external contact closure.
2. User-configured recording, to record for the duration of the alarm up to 300 seconds and can be delayed for 1 to 10 seconds.
3. Records current per-phase and neutral, voltage L-L each phase and L-N each phase, active power per-phase and three-phase total, reactive power each phase and three-phase total, apparent power each phase and three-phase total, and true power factor three-phase total.
4. Operate an output relay in the I/O module of the instrument.

T. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current in each phase and neutral, through the 255th harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.

2. The current and voltage information for phases must be obtained simultaneously from the same cycle.
3. Report harmonic information as a percentage of the fundamental or as a percentage of the RMS values, as selected by the user.

U. Alarms:

1. Alarm events may be either user defined or preconfigured by manufacturer from the applicable standards. Provide for multiple levels for each alarm that is based on metered data.
2. The instrument must calculate the listed key electrical parameters at not less than 100 ms intervals to initiate and record an alarm event. Provide for user-selected range of 1 to 10 seconds of pre-event and up to five minutes of post-event data recording.
3. The following classes of events must be available to be programmed as alarm events:

    a. Over/under current.
    b. Over/undervoltage.
    c. Current imbalance.
    d. Phase loss, current.
    e. Phase loss, voltage.
    f. Voltage imbalance.
    g. Wave shape alarm.
    h. Over kVA.
    i. Over kW or kVAR into/out of load.
    j. Over/under frequency.
    k. Under power factor, true or displacement.
    l. Over THD.
    m. Over K-factor.
    n. Over demand, current or power.
    o. Reverse power.
    p. Phase reversal.
    q. Status input change.
    r. End of incremental energy interval.
    s. End of demand interval.
    t. Over/under analog inputs.
    u. Current sag/swell.
    v. Voltage sag/swell.
    w. Transient events.

4. For each over/under metered alarm value, the user must define a pickup, dropout, and delay.
5. Waveform Alarms:

    a. The instrument must detect anomalous waveform events that are less than half-cycle in length.
    b. Provide for the user to set a threshold value and an upper limit to determine whether the waveform triggers an alarm. The threshold value and upper limit must be a value between 1 and 100. The threshold value is the limit at which a waveform triggers the alarm. The upper limit defines the highest waveform value that triggers a waveform alarm. The settable values are as follows:

        1) Phase voltages.
        2) N-G voltages.
        3) Phase currents.
        4) Neutral currents.

    c. In response to a waveform alarm, the instrument must:

1) Log the event and record phase currents and voltages as defined in the 100 ms event recording.
2) Determine the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, or high) of the accuracy of the source location.

6. Provide four alarm severity levels to allow the user to respond to the most important events first.
7. Indicate an alarm condition on the front panel of the instrument, as well as reported over the data link to designated workstations.
8. The circuit meter and monitor alarms response time must be not less than the following:

a. Standard, one second.
b. High speed, 100 ms.
c. Disturbance, half-cycle.

9. Up to four alarms may be combined to give a single result using Boolean algebra operations.
10. Provide e-mail notification of alarm conditions.
11. Automatic Alarm Set-Point Adjustment:

a. The instrument software must provide for recognizing and learning the characteristics of the normal operation of the electrical power system it is connected to, and to select and adjust alarm set points based on that recognition.
b. The metered data to be recognized and learned, and the period of time for learning for alarms, disturbances, and waveform alarms, must be set by the user by selection one of the following two modes:

1) Fixed Learning: Initially configured user set points are used during the entire learning period.
2) Dynamic Learning: Initially configured user set points are temporarily replaced by learned set points at the interval specified by the user in the learning setup. The set points continue to be updated at the specified interval until the learning period expires.

c. The learning period must be user configurable. If the learned set points do not change over a predefined period, the learning process can be stopped and the set points either installed or held for review.

V. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

W. I/O Module: Modular, with multiple I/O options, programmable to accomplish specified performance and one or more spare positions for future. At minimum, the instrument must provide the following:

1. KYZ Pulse: Solid-state output relay, programmed to generate a standard KYZ pulses for a user-defined increment of metered active energy as follows:

a. User-defined pulse output, associated with kWh.
b. Alarm pulse output, which turns on the pulsing at user-defined point.

2. Digital inputs, each having the following operating modes:

a. Normal: Simple on/off digital inputs.
b. Demand Interval Synch Pulse Accept a demand synch pulse from a utility demand meter.
c. Conditional Energy Control input to control conditional energy accumulation.

3. Output Relays and Control: Output relays must have normally open and normally closed contacts and must operate in response to a user sent command over the data link, or automatically responding to an alarm event. The relays must be user configured in one of the following listed modes:

    a. Normal contact closure where the contacts change state for as long as the signal exists.
    b. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
    c. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.
    d. End of Power Demand Interval: When the relay operates as a synch pulse for other devices.
    e. Energy Pulse Output: Relay will pulse quantities used for Absolute kWh, Absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
    f. Programmed Output: Relay will operate in response to multiple alarms that are arranged to give a single result using Boolean algebra operations.

X. Onboard Data Logs:

1. Log data, alarms and events, and waveforms in onboard solid-state nonvolatile memory.
2. Onboard data logs must be available for transmission over the communications network for display, archival, and analysis at computer workstations on demand.
3. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

    a. Each log entry must hold data of up to 96 parameters each.
    b. Each log must be user configurable to log data at a different user-defined schedule interval.
    c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
    d. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

4. Minimum/Maximum Logs:

    a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
    b. Minimum/Maximum log must include the time, date, and value for the minimum and maximum of each of the active-time metered values.

5. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. The log capacity must be not less than 1000 events. Record selected parameters at 100 ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
6. Waveform Logs: Capture and store waveforms as follows:

    a. One cycle, 512 samples, to the 255th harmonic. Manually triggered.
    b. Adjustable from 8 seconds at 18 samples per cycle, to 264 seconds at 16 samples per cycle. Triggered manually or by a user set alarm.
    c. Voltage sampling at 5 MHz (83,333 samples per cycle) more than 2 ms to capture transient peaks of less than 1 microsecond.

Y. Programming: Programming of instrument functions must be similar to BASIC syntax. Provide for initial programming and changes to programs through the communications links.

1. Programming language must include the following capabilities:

    a. Scheduled tasks.
    b. Event tasks.
    c. Math functions including add, subtract, multiple, divide, sine, cosine, and square root.
    d. Logical functions including: AND, OR, XOR, NOT, shift, and so forth.
    e. Loop commands.
    f. Compare statements.
    g. Counters and timers.

2. Manufacturer must provide custom programs to meet Project requirements that are described in "Capacities and Characteristics" Paragraph below.
3. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
4. Data reduction using smart data logging.
5. Automatic monthly logging/reset of kWh and peak demand.
6. Statistical profile analysis of metered quantities.
7. ITIC/SEMI power quality analysis.
8. Calculations for IEEE 519 verification.
9. Metering of combined utilities: gas, water, steam, and electric.
10. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions, for example, time of day and input status.

Z. Capacities and Characteristics:

1. Power Supply: [**120 V(ac), 60 Hz**]<**Insert text**>.
2. Circuit Connections:

    a. Voltage: Measurements autoranging, zero to 600 V(ac) L-L, zero to 347 V(ac) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument grade potential transformers secondary at 120 V.**] Meter impedance must be 2 megohm L-L or greater.
    b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 15 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
    c. Frequency: 45 to 67 Hz, and 350 to 450 Hz.
    d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

3. Onboard, Field-Upgradeable, Solid-State Nonvolatile Memory: [**8**]<**Insert number**> MB.
4. Number of Onboard Data Logs: [**14**]<**Insert number**>.
5. Number of Minimum/Maximum Log Files: [**Two**]<**Insert number**>.
6. Alarm Log Capacity: Not less than 1000 events.
7. Custom Programs: Provide the following programs with the instrument:

    a. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
    b. Data reduction using smart data logging.
    c. Automatic monthly logging/reset of kWh and peak demand.
    d. Statistical profile analysis of metered quantities.
    e. Calculations for IEEE 519 verification.
    f. Metering of combined utilities: gas, water, steam, and electric.
    g. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions such as time of day and input status.
    h. <**Insert requirements**>.

2.7 PC OPERATING SYSTEM SOFTWARE

A. Description: System software must monitor, analyze, display, control, and save the parameters and features available at the connected meter.

B. Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.

C. Minimum Requirements:

1. Real-time multitasking and multiuser [**32-**][**or**][**64-**]bit operating system that allows execution of multiple real-time programs and custom program development.
2. Operating system must be capable of operating Microsoft Windows applications.
3. Scheduling software must schedule centrally based time and event, temporary, and exception day programs.

2.8 NETWORKED PC OPERATING SYSTEM SOFTWARE

A. Description: System software must monitor, analyze, display, control, and save parameters and features available at each of the connected meters.

B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software must include interactive graphics client and must be web enabled.

C. System Software Minimum Requirements:

1. Real-time multitasking and multiuser [**32-**][**or**][**64-**]bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system must be capable of operating Microsoft Windows applications.
3. Database management software must manage data on an integrated and non-redundant basis. Additions and deletions to database must be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Scheduling software must schedule centrally based time and event, temporary, and exception day programs.

D. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.
3. Operator sign-off must be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period must be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity.
6. Security Access:

a. Operator access to electrical monitoring and control system must be under password control.
b. An alphanumeric password must be user assignable to each operator.
c. Software must have at least five access levels.

1) View - View information. No change privileges allowed.
2) User - Same as View, but is able to initiate control functions.
3) Controller - Same as User, but is able to initiate communications.
4) Operator - Same as Controller, but is able to modify configurations.
5) Supervisor - Same as Operator, but is able to administer security privileges.

d. Each menu item must be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
e. Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments must be online programmable and under password control.

E. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
2. Descriptors for graphics, points, alarms, and such must be modified through workstation under password control.
3. Display operator accessed data on the monitor.
4. Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

2.9 POWER MONITORING AND CONTROL SOFTWARE

A. Data Storage and Data Sharing:

1. Query and download logs of interval data stored on metering devices.
2. Query and download logs of alarm and event data stored on metering devices.
3. Query and download logs of waveform capture data stored on metering devices.
4. Query and download logs of interval data generated by the software and calculated by the meters.
5. Query and download logs of alarm and event data generated by the software and calculated by the meters.
6. Automatically re-arm the waveform recorders, on upload of information.
7. Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
8. Provide a facility to view historical data from archived databases.
9. Support user changes to the database.

a. Support on-line changes while the data storage/retrieval application is running.
b. Suffer no interruption to its operation while changes are being made.
c. Require no restart once the configuration has been performed.

B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
2. Plan for each building floor, showing the following:

a. Locations and identification of monitored and controlled electrical equipment.
b. <**Insert requirements**>.

3. Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation[**, similar to that indicated on Drawings,**] with device

identification.

4. Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
5. Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters, [**gateways**][**and**][**other network devices**].

2.10 NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:

1. Add and remove devices in the power monitoring and control network.
2. Application for naming devices based on a user-defined naming scheme.
3. Add and remove I/O servers in the power monitoring and control network.
4. Edit communication properties for devices including timeouts and delays.
5. Display mandatory fields when adding a new device.
6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.
7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
8. Pool modem resources so that the software uses any available modem.
9. Monitor the following diagnostics:

    a. Communication request/response and error rates, and timeouts.
    b. Log acquisition services.

B. Database Maintenance Features:

1. Backup, archive, and trim data, event, and waveform logs.

    a. Record start and end date for operation.
    b. Allow copying data to another database.
    c. Be capable of selecting logs specified for the meters that are Work of this Section.

        1) Data logs.
        2) Event logs.
        3) Waveform logs.

C. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.

1. Features:

    a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
    b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
    c. Distribution of reports via email.

2. Report on power and demand profiles.
3. Power quality report with CBEMA evaluation.
4. EN 50160 compliance report.
5. 100 ms PQ report.
6. Energy over Period Report:

    a. User-defined rollup interval by day, week, month, or year.
    b. Compare daily energy to the following:

        1) Previous day.

2) Same day, previous week.
3) Same day, previous month.
4) User-defined specific day.

c. Compare weekly energy to the following:

1) Previous week.
2) Same week from previous month.
3) Same week from previous year.
4) User-defined specific week.

d. Compare monthly energy to the following:

1) Previous month.
2) Same month from previous year.
3) User-defined specific month.

e. Compare annual energy to the following:

1) Previous year.
2) User-defined specific year.

7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
9. Trend Report:

a. Show values for multiple measurements and measurements from multiple devices in the following graphical formats:

1) Line chart.
2) Pie graph.
3) Bar chart.
4) Column chart.
5) Smooth line chart.
6) Stacked column chart.
7) Stacked bar chart.

10. Alarm and Event History: User formatted, based on the meters and priority; and with user-defined alarm and event reports.
11. System Configuration Report:

a. Device name.
b. Device type.
c. Device address.
d. Connection status.
e. Device protocol.
f. Device description.

12. Each default report must include the following:

a. Summary aggregation of data from the selected devices.
b. Individual device information.
c. Raw data.

13. The reporting tool must provide a graphical interface to create and manage multiple Time of Use schedules:

    a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
    b. Off-peak and on-peak times.

2.11 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

B. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C. Ethernet Connectivity:

1. A multipoint, MODBUS TIA-485 serial communications network must be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network must be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network must be included within the power distribution equipment.
3. Serial communications devices within the equipment must be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D. Ethernet Gateways:

1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (8PSJ) Ethernet port, that is accessible from the front of the equipment. Initial setup must be limited to basic Ethernet addressing parameters, as assigned by Owner.
3. Common Gateway Features:

    a. User configurable, with secure password-protected login process.
    b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
    c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's TIA-485 port(s) through a standard web browser.
    d. Allow firmware upgrades through the communications port.

4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
5. Implement a common user interface ("look and feel") across different styles of power equipment.

E. Distribution Equipment Monitoring:

1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
2. Display Data:

a. Circuit summary page to display circuit name, three-phase average RMS current, real power (kW), power factor, and breaker status (if applicable).
b. Load current summary page to display circuit name, and phase a, b, and c RMS current values.
c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above must be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
g. For motor-control centers, the circuit summary web page must be tailored specifically for this application, to display circuit name, three-phase average RMS current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.12 SYSTEM OPERATOR INTERFACES

A. Operator means of system access must be through the following:

1. Desktop workstation with hardwired connection through LAN port.
2. Portable terminal with hardwired connection through LAN port at each meter.
3. Remote connection using outside of system PC, tablet, or phone using an internet portal.

2.13 DESKTOP WORKSTATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Capable of running [**Microsoft Windows**]<**Insert operating system name**>.
3. ENERGY STAR compliant.

D. Personal Computer:

1. Minimum Processor Speed: <**Insert gigahertz**>, [**Core i3**][**Core i5**][**Core i7**].
2. RAM:

    a. Capacity: [**2**][**4**][**8**]<**Insert value**>[**GB**].
    b. Speed and Type: [**1333**]<**Insert value**> MHz, <**Insert type**>.

3. Primary Hard Drive:

    a. Media: [**Solid state**][**Rotating disc, nominal rotational speed of 7200 rpm**][**Hybrid solid-state and rotating disc**].
    b. Number of Hard Drives: [**One**][**Two**]<**Insert number**>.
    c. Capacity: <**Insert number and measurement unit**>.
    d. Minimum Average Seek Time: <**Insert number and measurement unit**>.
    e. Cache Buffer Size: <**Insert number and measurement unit**>.
    f. <**Insert requirements**>.

4. Second Hard Drive:

    a. Media: [**Solid state**][**Rotating disc, nominal rotational speed of 7200 rpm**][**Hybrid solid-state and rotating disc**].
    b. Capacity: <**Insert number and measurement unit**>.
    c. Minimum Average Seek Time: <**Insert number and measurement unit**>.
    d. Cache Buffer Size: <**Insert number and measurement unit**>.
    e. <**Insert requirements**>.

5. Optical Drive:

    a. Type: <**Insert type**>.
    b. Minimum Average Access Time: <**Insert number**> ms.
    c. Data Transfer Speed: <**Insert number**>[**MB**][**TB**]/s.
    d. Reading Formats: Data, audio, recordable, <**Insert other**> and rewritable.

6. Optical Read and Write Drive:

    a. Include with at least 2 MB of data buffer.
    b. Type: <**Insert type**>.
    c. Minimum Data Buffer Capacity: <**Insert number and measurement unit**>.
    d. Minimum Average Access Time: <**Insert number**> ms.
    e. Nominal Data Transfer Rates:

        1) Reading: <**Insert number**>[**MB**][**TB**]/s.
        2) Writing: <**Insert number**>[**MB**][**TB**]/s.

    f. Average access time of 150 ms or less.
    g. MTBF of at least 100,000 power-on hours.

7. Expansion Slots: Minimum of 4, [**32**][**64**]<**Insert number**> bit.
8. Video Card:

    a. Capable of supporting [**one**][**two**][**three**][**four**] monitors.
    b. Resolution: [**1920 by 1200**]<**Insert values**> pixels minimum for each monitor.
    c. RAM: <**Insert number**>[**GB**][**TB**].
    d. Controller Speed: <**Insert number**>[**MHz**][**GHz**].
    e. On-Board Memory Speed: <**Insert number**>[**MHz**][**GHz**].
    f. On-Board Memory Data Width: <**Insert number**> bit.

9. Sound Card:

    a. At least 128 voice wavetable synthesis.
    b. Capable of delivering three-dimensional sound effects.
    c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

10. Network Interface Card: Include card with connection, as applicable.

    a. 10-100-1000 base TX Ethernet with 8PSJ connector port.
    b. 100 base FX Ethernet with SC or ST port.

11. Wireless Ethernet, 802.11 a/b/g/n.
12. Optical Modem: Full duplex link for connection to optical fiber cable provided.
13. I/O Ports:

    a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
    b. One serial port.
    c. One parallel port.
    d. Two PS/2 ports.
    e. One 8PSJ.
    f. One stereo line-in and line-out on back panel.
    g. One microphone and headphone connector on front panel.
    h. One IEEE 1394 on front and back panel with PCI-e card.
    i. One ESATA port on back panel.

14. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

E. Keyboard:

1. 101-key enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to **72 inch (1800 mm)** in front of workstation.

F. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to **72 inch (1800 mm)** in front of workstation.

G. Flat Panel Display Monitor:

1. Number of Displays: [**One**][**Two**]<**Insert number**>.

    a. Display Support: [**Individual tilt adjustable base.**][**Desk mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization.**][**Wall mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization.**]<**Insert description.**>

2. Color display with <**Insert inch (mm)**> diagonal viewable area.
3. Aspect Ratio: [**16 to 9**]<**Insert value**>.
4. Resolution: [**1920 by 1080**]<**Insert value**> pixels at 60 Hz with pixel size of [**0.277**]<**Insert number**> mm or smaller.
5. [**Digital**][**or**][**analog**] input signal.

6. Response Time: <**Insert number**> ms.
7. Dynamic Contrast Ratio: [**50000 to 1**]<**Insert ratio**>.
8. Brightness: [**250 cd/sq. m**]<**Insert value**>.
9. ENERGY STAR compliant.
10. Antiglare display.

H. Speakers:

1. Two, with individual controls for volume, bass, and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

I. I/O Cabling: Include applicable cabling to connect I/O devices.

J. Software:

1. Factory-installed operating system.

2.14 PORTABLE WORKSTATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. ENERGY STAR compliant.
3. Hardware and software must support local downloading to DDC controllers.
4. Data transfer rate to DDC controller must be at network speed.

D. Processor:

1. Minimum Processor Speed: <**Insert gigahertz**>.
2. RAM:

    a. Capacity: <**Insert value**>[**GB**][**TB**].
    b. Speed and Type: <**Insert value**> MHz, <**Insert type**>.

3. Hard Drive:

a. Media: [**Solid state**][**Rotating disc, nominal rotational speed of 7200 rpm**][**Hybrid solid-state and rotating disc**].
b. Number of Hard Drives: [**One**][**Two**]<**Insert number**>.
c. Capacity: <**Insert number and measurement unit**>.
d. Minimum Average Seek Time: <**Insert number and measurement unit**>.
e. Cache Buffer Size: <**Insert number and measurement unit**>.
f. <**Insert requirements**>.

4. Video Card: <**Insert number and measurement unit**> of RAM.

E. Input and Output Ports:

1. Serial port.
2. Shared port for external keyboard or mouse.
3. Four USB 3.0 ports.
4. Ethernet port.
5. HDMI port.
6. IEEE 1394 port.

F. Battery:

1. Capable of supporting operation of portable workstation for a minimum of [**8**]<**Insert number**> hours.
2. Battery life of at least three years.
3. Battery charge time of less than three hours.
4. Spare Batteries: [**One**][**Two**].

G. Keyboard:

1. 85-key [**backlit**]keyboard.
2. Full upper- and lowercase ASCII keyset.

H. Integral Pointing Device: Touchpad with two buttons. Gesture enabled.

I. Display:

1. <**Insert inch (mm)**> diagonal or larger high-definition WLED color display.
2. Antiglare screen.
3. [**1920 by 1080**]<**Insert value**> pixel resolution.
4. Brightness: 300 nits.

J. Network Interfaces:

1. Network Interface Card: Include card with connection, as application.

a. 10-100-1000 base TX Ethernet with 8PSJ connector port.
b. 100 base FX Ethernet with SC or ST port.

2. Wireless:

a. Internal with integrated antenna, capable of supporting 802.11 a/b/g/n.

K. Digital Video Disc Rewrite Recorder (DVD+/-RW):

1. Compatible with DVD disks and data, audio, recordable and rewritable compact disks.
2. Nominal Data Transfer Rates:

    a. Reading: <**Insert number**>[**MB**][**TB**]/s.
    b. Writing: <**Insert number**>[**MB**][**TB**]/s.

3. 160 ms access time.

L. Accessories:

1. Nylon carrying case.
2. Docking station.
3. Mobile broadband card.
4. Wireless optical mouse.
5. <**Insert value**>[**GB**][**TB**] portable hard drive.
6. Light-sensitive web cam and noise-cancelling digital array microphone.
7. Category 6a patch cable. Minimum cable length must be <**Insert length**>.
8. HDMI cable. Minimum cable length must be <**Insert length**>.

2.15 RACEWAYS AND BOXES

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceways for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for control wiring, TIA-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

2.16 WIRES AND CABLES

A. Electrical Power Wiring: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Copper conductors are Type THHN/THWN-2.

B. Control Wiring: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

1. Optical-Fiber Cable: Multimode, 50/125 micrometer OM3, six-fiber, [**nonconductive,**]tight-buffer, optical-fiber cable, with aqua jacket.
2. Balanced Twisted Pair Cable: 100 ohm, four-pair [**Category 5e**][**Category 6**].
3. Workstation Outlets: Four-port-connector assemblies mounted in single or multigang faceplate. Coordinate color and labels with Section 262726 "Wiring Devices."
4. TIA-485 Cable: Paired, [**one pair**][**two pairs**], twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
5. Control-Voltage Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

    a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
    b. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
    c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

C. TIA-232 Cable:

1. PVC-Jacketed, TIA-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper

conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

a. Type CM.
b. Flame Resistance: UL 1581, vertical tray.

2. Plenum-Type, TIA-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

a. Type CMP.
b. Flame Resistance: NFPA 262, flame test.

2.17 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Eaton**]
5. [**Emerson Electric Co., Automation Solutions**]
6. [**LEA International**]
7. [**Leviton Manufacturing Co., Inc.**]
8. [**Mersen USA**]
9. [**PowerLogics, Inc./PQ Protection**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Energy Management Division**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Eaton**]
5. [**Emerson Electric Co., Automation Solutions**]
6. [**LEA International**]
7. [**Leviton Manufacturing Co., Inc.**]
8. [**Mersen USA**]
9. [**PowerLogics, Inc./PQ Protection**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Energy Management Division**]
12. <**Insert manufacturer's name**>

C. SPDs: Comply with UL 1449, [**Type 1**][**Type 2**].

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor

components.

3. Include Form-C contacts rated at 5 A and 250 V(ac), one normally open and one normally closed, for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase must not be less than [**100 kA**]<**Insert value**>. The peak surge current rating must be the arithmetic sum of the ratings of the individual metal-oxide varistors in a given mode.

E. Comply with UL 1283.

F. Protection modes and UL 1449 SPD for grounded wye circuits with [**480Y/277 V**][**208Y/120 V**], three-phase, four-wire circuits must not exceed the following:

1. L-N: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
2. L-G: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
3. N-G: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
4. L-L: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**].

G. Protection modes and UL 1449 SPD for 240/120 V, single-phase, three-wire circuits must not exceed the following:

1. L-N: 700 V.
2. L-G: 700 V.
3. N-G: 700 V.
4. L-L: 1200 V.

H. SCCR: Equal or exceed [**100**][**200**]<**Insert value**> kA.

I. Nominal Rating: [**20**][**10**] kA.

J. Indoor Enclosures: NEMA 250, Type 1.

K. Outdoor Enclosures: NEMA 250, [**Type 3R**][**Type 4**][**Type 4X**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF POWER MONITORING AND CONTROL SYSTEMS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and

without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Wiring and Cabling Installation:

1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 260523 "Control-Voltage Electrical Power Cables" for control wiring.

D. Raceways Installation:

1. Comply with Section 260533.13 "Conduits for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
2. Comply with Section 270528 "Pathways for Communications Systems" for control wiring, TIA-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

E. Identification Installation:

1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for twisted pair cable, TIA-485 cable, control-voltage cable, and TIA-232 cable.
3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for identification products and cable management system requirements for optical-fiber cable.

3.3 INSTALLATION OF WORKSTATIONS

A. Desktop Workstations Installation:

1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex electrical power receptacle.
3. Install software on workstation(s) and verify that software functions properly.
4. Develop Project-specific graphics, trends, reports, logs, and historical database.
5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstations Installation:

1. Turn over portable workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify that software functions properly.

C. Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of text for each graphic for Owner's[**and Architect's**] review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing must be done on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the

system operation and maintenance manual.

3.4 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.5 GROUNDING

A. For data communication wiring, comply with BICSI N1.

B. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of components.
4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

5. Optical-Fiber Cable Tests:

    a. Test instruments must meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.
        2) Attenuation test results for links must be less than [**2.0 dB**][**that calculated according to equation in TIA-568-C.0**].

c. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

6. Power Monitoring and Control System Tests.

a. Test Analog Signals:

1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

b. Test Digital Signals:

1) Check digital signals using a jumper wire.
2) Check digital signals using an ohmmeter to test for contact making or breaking.

c. I/O Control Loop Tests:

1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2) Test every I/O point throughout its full operating range.
3) Test every control loop to verify that operation is stable and accurate.
4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5) Test and adjust every control loop for proper operation according to sequence of operation.
6) Test software and hardware interlocks for proper operation.
7) Operate each analog point at the following:

a) Upper quarter of range.
b) Lower quarter of range.
c) At midpoint of range.

8) Exercise each binary point.
9) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument must match.
10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

C. Nonconforming Work:

1. Wiring and cabling will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 FINAL REVIEW

A. Submit written request to Architect [**and**][**Construction Manager**] when the power monitoring and control system is ready for final review. Written request must state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
4. The system is complete and ready for final review.

B. Review by [**Architect**][**and**][**Construction Manager**] will be made after receipt of written request. A field report must be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Final review must include a demonstration to parties participating in final review.

3.8 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service must include [**three**][**six**][**nine**][**12**] months' full maintenance by manufacturer's authorized service representative. Include [**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

3.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement must include software support for [**two**]<**Insert number**> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.10 TRAINING

A. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of training materials and visual presentations.
2. Hard-copy materials must be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of hard-copy materials.

B. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor must provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training must include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. The workstation provided with the system must be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

C. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project monitoring and control system for use in training.
3. Provide a workstation for use by each attendee.

D. At Completion of Training: Staff familiar with the system installed are capable of demonstrating operation of the system during final review.

E. Demonstration must include, but not be limited to, the following:

1. Accuracy and calibration of [**10**]<**Insert number**> I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
3. Trends, summaries, logs, and reports set-up for Project.
4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
5. Software's ability to edit control programs off-line.
6. Data entry to show Project-specific customizing capability including parameter changes.
7. Step through penetration tree, display graphics, demonstrate dynamic update, and direct access to graphics.
8. Execution of digital and analog commands in graphic mode.
9. Spreadsheet and curve plot software and its integration with database.
10. Online user guide and help functions.
11. For Each Meter:

    a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
    b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
    c. Wiring Labels: Match control drawings.
    d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
    e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

12. For Each Workstation:

    a. I/O point lists agree with naming conventions.
    b. Graphics are complete.

c. UPS unit, if applicable, operates.

END OF SECTION 26 09 23 00

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SECTION 26 09 23 00A - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Outdoor photoelectric switches.
3. Daylight-harvesting controls.
4. Business occupancy and vacancy sensors.
5. Storage occupancy sensors.
6. Outdoor motion sensors.
7. Industrial control switches.
8. Emergency lighting controls.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of lighting control devices referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. [**Section 262726 "Wiring Devices"**][**Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches"**] for wall-box dimmers and manual light switches.

1.2 DEFINITIONS

A. BCELTS: Branch circuit emergency lighting transfer switch.

B. DPDT: Double pole double throw.

C. DPST: Double pole single throw.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. PIR: Passive infrared.

G. SPDT: Single pole double throw.

H. SPST: Single pole single throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. ASHRAE/IES 90.1 LPD Compliance Documentation: Prepare plans and calculations demonstrating that as-constructed lighting power density complies with mandatory provisions of ASHRAE/IES 90.1 and that as-constructed lighting, including daylighting and controls, improves on baseline energy performance. If included with Project, indicate locations of energy meters for lighting loads.
2. Lighting Control Documentation: Floor plans indicating the following information:

a. As-installed locations of switches and dimmers.
b. Lighting zones and control strategy for each switch or dimmer, including unoccupied time-delay setting for shut-off and override time-delay setting for shut-off.
c. Multilevel or dimming range capability for each switch or dimmer.
d. Which switches or dimmers are operated by occupancy sensors, vacancy sensors, daylighting sensors, or time clocks.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for software and firmware upgrades.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Software and firmware service agreement.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multiteam projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that installed lighting control devices perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that lighting control devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Failures include, but are not limited to, the following:

    a. Faulty operation of lighting control software.
    b. Faulty operation of lighting control devices.
    c. <**Insert failure modes**>.

2. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
3. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements:

1. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Must comply with CCR Title 24.

2.2 TIME SWITCHES

A. UL WGZR - Electronic Time Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**Intermatic, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**nLight; Acuity Brands Lighting, Inc.**]
    e. [**NSi Industries LLC**]
    f. [**Schneider Electric USA, Inc.**]
    g. [**TE Connectivity Ltd.**]
    h. [**Touché Lighting Control**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]
    b. [**Intermatic, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**nLight; Acuity Brands Lighting, Inc.**]
    e. [**NSi Industries LLC**]
    f. [**Schneider Electric USA, Inc.**]

g. [**TE Connectivity Ltd.**]
h. [**Touché Lighting Control**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Clock-Operated Switches: UL CCN WGZR, including UL 917.

5. Standard Features:

   a. Contact Configuration: [**SPST**][**DPST**][**DPDT**]<**Insert configuration**>.
   b. Contact Rating: [**30 A inductive or resistive, 240 V(ac)**][**20 A driver load, 120/240 V(ac)**]<**Insert rating**>.
   c. Programs:

      1) Eight on-off set points on a 24-hour schedule[**and an annual holiday schedule that overrides the weekly operation on holidays**].
      2) Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week[**and an annual holiday schedule that overrides the weekly operation on holidays**].
      3) <**Insert number**> channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
      4) <**Insert number**> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule with a skip-a-day weekly schedule.
      5) <**Insert number**> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
      6) <**Insert number**> channels; each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
      7) <**Insert number**> channels; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program and an annual holiday schedule that overrides the weekly operation on holidays.
      8) <**Insert configuration**>[**and an annual holiday schedule that overrides the weekly operation on holidays**].

   d. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program[**on selected channels**].
   e. Astronomic Time: [**All**][**Selected**] channels.
   f. Automatic daylight savings time changeover.
   g. Battery Backup: Not less than seven days' reserve, to maintain schedules and time clock.

B. UL WGZR - Electromechanical-Dial Time Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**NSi Industries LLC**]

e. [**Schneider Electric USA, Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Intermatic, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**NSi Industries LLC**]
e. [**Schneider Electric USA, Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Clock-Operated Switches: UL CCN WGZR, including UL 917.

5. Standard Features:

a. Contact Configuration: [**SPST**][**DPST**][**SPDT**][**DPDT**]<**Insert configuration**>.
b. Contact Rating: [**30 A inductive or resistive, 240 V(ac)**][**20 A driver load, 120/240 V(ac)**]<**Insert rating**>.
c. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
d. Astronomic time dial.
e. Eight-Day Program: Uniquely programmable for each weekday and holidays.
f. Skip-a-day mode.
g. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of [**16**]<**Insert number**> hours.

C. UL WGZR - Digital Timer Light Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Intermatic, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**nLight; Acuity Brands Lighting, Inc.**]
e. [**NSi Industries LLC**]
f. [**Schneider Electric USA, Inc.**]
g. [**TE Connectivity Ltd.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Intermatic, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**nLight; Acuity Brands Lighting, Inc.**]
e. [**NSi Industries LLC**]
f. [**Schneider Electric USA, Inc.**]
g. [**TE Connectivity Ltd.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Clock-Operated Switches: UL CCN WGZR, including UL 917.

5. Standard Features:

   a. Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in [**10**][**20**]-minute increments.
   b. Rated 960 W at 120 V(ac) for tungsten lighting, 10 A at 120 V(ac) or 10 A at 277 V(ac) for fluorescent or LED lighting, and 1/4 hp at 120 V(ac).
   c. Standards: Comply with UL 20.
   d. Integral relay for connection to BAS.
   e. Voltage: [**Match the circuit voltage**][**120 V**][**277 V**][**Dual voltage - 120 and 277 V**].
   f. Color: [**White**][**Black**]<**Insert color**>.
   g. Faceplate: Color matched to switch.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES

A. UL WJFX - Solid-State Outdoor Photoelectric Switch, Flexible Mounting :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]

g. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

5. Standard Features:

   a. Solid state, with [**SPST**][**DPST**]<**Insert configuration**> dry contacts rated for [**1000 W incandescent**][**or**][**1800 VA inductive**]<**Insert value**>, to operate connected relay, contactor coils, or microprocessor input; and compatible with drivers and LED lamps.
   b. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   c. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lx)**, with an adjustment for turn-on and turn-off levels within that range[**, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off**].
   d. Time Delay: Fifteen-second minimum, to prevent false operation.
   e. Surge Protection: Metal-oxide varistor.
   f. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure[**from same source and manufacturer as switch**].
   g. Failure Mode: Luminaire stays ON.

B. UL WJFX - Solid-State Outdoor Photoelectric Switch, Luminaire-Mounted :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**Intermatic, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**nLight; Acuity Brands Lighting, Inc.**]
   e. [**NSi Industries LLC**]
   f. [**TE Connectivity Ltd.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

5. Standard Features:

    a. Solid state, with [**SPST**][**DPST**] dry contacts rated for [**1000 W incandescent**][**or**][**1800 VA inductive**], to operate connected load, and compatible with CFL and LED lamps.
    b. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lx)**, with an adjustment for turn-on and turn-off levels within that range.
    c. Time Delay: Thirty-second minimum, to prevent false operation.
    d. Lightning Arrester: Air-gap type.
    e. Mounting: Twist lock complying with ANSI C136.10, with base[**from same source and manufacturer as switch**].
    f. Failure Mode: Luminaire stays ON.

C. UL WJFX - Solid-State, Low-Voltage, Outdoor Photoelectric Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**Intermatic, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**nLight; Acuity Brands Lighting, Inc.**]
    e. [**NSi Industries LLC**]
    f. [**TE Connectivity Ltd.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]
    b. [**Intermatic, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**nLight; Acuity Brands Lighting, Inc.**]
    e. [**NSi Industries LLC**]
    f. [**TE Connectivity Ltd.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

5. Standard Features:

    a. Solid state; one set of N.O. dry contacts rated for [**24 V(dc) at 1 A**][**24 V(ac) at 1 A**], to operate connected load, and compatible with [**luminaire**][**power pack**][**lighting control**

panelboard].

b. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lx)**, with an adjustment for turn-on and turn-off levels within that range.
c. Time Delay: Thirty-second minimum, to prevent false operation.
d. Mounting: **1/2 inch (13 mm)** threaded male conduit.
e. Failure Mode: Luminaire stays ON.
f. Power Pack:

1) Dry contacts rated for [**20 A**]<**Insert value**>[**driver**][**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**]<**Insert value**> tungsten at 120 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.

a) LED status lights to indicate load status.
b) Plenum rated.

2) Digital controller capable of accepting [**three**][**four**]<**Insert number**> 8PSJ inputs with [**one**][**two**] outputs rated for [**20 A**]<**Insert value**> incandescent[**or LED**] load at 120 and 277 V(ac), for [**13 A**][**16 A**]<**Insert value**>[**driver**][**or**][**LED**] at 120 and 277 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc), Class 2 power source.

a) With integral current monitoring.
b) Compatible with digital addressable lighting interface.
c) Plenum rated.

2.4 DAYLIGHT-HARVESTING CONTROLS

A. UL WJCT - Daylight-Harvesting Control Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**nLight; Acuity Brands Lighting, Inc.**]
f. [**NSi Industries LLC**]
g. [**Sensor Switch, Inc**]
h. [**TE Connectivity Ltd.**]
i. [**WattStopper; Legrand North America, LLC**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]

d. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
e. [**nLight; Acuity Brands Lighting, Inc.**]
f. [**NSi Industries LLC**]
g. [**Sensor Switch, Inc**]
h. [**TE Connectivity Ltd.**]
i. [**WattStopper; Legrand North America, LLC**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Photoelectric Switches: UL CCN WJCT, including UL 773A.

5. Standard Features:

   a. System operates indoor lighting.
   b. Ceiling-Mounted Switching Controls:

      1) Solid-state, light-level sensor unit, with [**integrated**]power pack, that detects changes in indoor lighting levels that are perceived by the eye.
      2) Solid-state, light-level sensor unit, with separate power pack[**mounted on luminaire**], that detects changes in indoor lighting levels that are perceived by the eye.

   c. Operating Ambient Conditions: Dry interior conditions, **32 to 120 deg F (0 to 49 deg C)**.
   d. Sensor Output:

      1) Contacts rated to operate the associated power pack, complying with UL 773A. Sensor must be powered by the power pack.
      2) Digital signal compatible with power pack.

   e. Sensor Type: [**Open loop**][**Closed loop**].
   f. Zone: [**Single**][**Multi**].
   g. Power Pack:

      1) Dry contacts rated for [**20 A**]<**Insert value**>[**driver**][**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**]<**Insert value**> tungsten at 120 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.

         a) LED status lights to indicate load status.
         b) Plenum rated.

      2) Digital controller capable of accepting [**three**][**four**]<**Insert number**> 8PSJ inputs with [**one**][**two**] outputs rated for [**20 A**]<**Insert value**> incandescent [**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**][**16 A**]<**Insert value**>[**driver**][**or LED**] at 120 and 277 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc) Class 2 power source.

         a) With integral current monitoring
         b) Compatible with digital addressable lighting interface.
         c) Plenum rated.

   h. General Space Sensors Light-Level Monitoring Range: **10 to 200 fc (108 to 2152 lx)**, with an adjustment for turn-on and turn-off levels within that range.

i. Atrium Space Sensors Light-Level Monitoring Range: **100 to 1000 fc (1080 to 10 800 lx)**, with an adjustment for turn-on and turn-off levels within that range.
j. Skylight Sensors Light-Level Monitoring Range: **1000 to 10 000 fc (10 800 to 108 000 lx)**, with an adjustment for turn-on and turn-off levels within that range.
k. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
l. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
m. Test Mode: User selectable, overriding programmed time delay to allow settings check.
n. Control Load Status: User selectable to confirm that load wiring is correct.
o. Indicator: Two digital displays to indicate the beginning of on-off cycles.

6. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.

a. Lighting control set point is based on two lighting conditions:

1) When no daylight is present.
2) When significant daylight is present (target level).

b. System programming is done with two handheld, remote-control tools.

B. UL WJCT - Daylight-Harvesting Analog Control Dimmer :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deep Roof Lighting**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**WattStopper; Legrand North America, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deep Roof Lighting**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**WattStopper; Legrand North America, LLC**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Photoelectric Switches: UL CCN WJCT, including UL 773A.

5. Standard Features:

a. Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
b. System programming is done with two handheld, remote-control tools.

1) Initial setup tool.
2) Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

c. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with [**integrated**][**separate**] power pack[**mounted on luminaire**], to detect changes in indoor lighting levels that are perceived by the eye.
d. Sensor Output: 0-10 V(dc) to operate luminaires. Sensor is powered by controller unit.
e. Light-Level Sensor Set-Point Adjustment Range: **20 to 60 fc (120 to 640 lx)**.
f. Power Pack: Dry contacts rated for [**20 A**]<**Insert value**>[**driver**][**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**]<**Insert value**> tungsten at 120 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.

1) LED status lights to indicate load status.
2) Plenum rated.

6. Sequence of Operation: Lighting control set point is based on two lighting conditions:

a. When no daylight is present (target level).
b. When significant daylight is present.

C. UL WJCT - Daylight-Harvesting Digital Control Dimmer :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deep Roof Lighting**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**nLight; Acuity Brands Lighting, Inc.**]
g. [**WattStopper; Legrand North America, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deep Roof Lighting**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]

f. [**nLight; Acuity Brands Lighting, Inc.**]
g. [**WattStopper; Legrand North America, LLC**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Photoelectric Switches: UL CCN WJCT, including UL 773A.

5. Standard Features:

   a. Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
   b. System programming is done with two handheld, remote-control tools.

      1) Initial setup tool.
      2) Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

   c. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with [**integrated**][**separate**] power pack[**mounted on luminaire**], to detect changes in indoor lighting levels that are perceived by the eye.
   d. Sensor Output: 0-10 V(dc) to operate luminaires. Sensor is powered by controller unit.
   e. Light-Level Sensor Set-Point Adjustment Range: **20 to 60 fc (120 to 640 lx)**.
   f. Power Pack: Digital controller capable of accepting [**three**][**four**]<**Insert number**> 8PSJ inputs with [**one**][**two**] output(s) rated for [**20 A**]<**Insert value**> incandescent [**or**][**LED**] load at 120 and 277 V(ac), for [**13 A**][**16 A**]<**Insert value**>[**driver load**][**or**][**LED**] at 120 and 277 V(ac), and for [**1 hp**]<**Insert value**> at 120 V(ac). Sensor has 24 V(dc) Class 2 power source.

      1) With integral current monitoring.
      2) Compatible with digital addressable lighting interface.
      3) Plenum rated.

6. Sequence of Operation: Lighting control set point is based on the following two lighting conditions:

   a. When no daylight is present (target level).
   b. When significant daylight is present.

2.5 BUSINESS OCCUPANCY AND VACANCY SENSORS

A. Passive-Infrared (PIR) Occupancy or Vacancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ademco; Honeywell**]
   b. [**ADT Security Services, Inc**]
   c. [**Cooper Lighting Solutions; Signify North America Corp.**]

d. [**Crestron Electronics, Inc.**]
e. [**Honeywell Security Group**]
f. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Leviton Manufacturing Co., Inc.**]
h. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
i. [**Lutron Electronics Co., Inc**]
j. [**Napco Security Technologies, Inc.**]
k. [**Pass & Seymour; Legrand North America, LLC**]
l. [**RAB Lighting**]
m. [**WattStopper; Legrand North America, LLC**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ademco; Honeywell**]
b. [**ADT Security Services, Inc**]
c. [**Cooper Lighting Solutions; Signify North America Corp.**]
d. [**Crestron Electronics, Inc.**]
e. [**Honeywell Security Group**]
f. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Leviton Manufacturing Co., Inc.**]
h. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
i. [**Lutron Electronics Co., Inc**]
j. [**Napco Security Technologies, Inc.**]
k. [**Pass & Seymour; Legrand North America, LLC**]
l. [**RAB Lighting**]
m. [**WattStopper; Legrand North America, LLC**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Photoelectric Controls: UL CCN WJCT, including UL 773A.
b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. [**Wall**][**Ceiling**]-mounted, solid-state indoor [**occupancy**][**and**][**vacancy**] sensors.
b. [**Integrated**][**Separate**] power pack.
c. [**Hardwired**][**Wireless**] connection to switch[**and BAS**][**; and BAS and lighting control system**].
d. Sensor Output: [**Contacts rated to operate the connected relay, complying with UL 773A**][**Sensor is powered from the power pack**][**Wireless**].
e. Power: [**Line voltage**][**Integral photovoltaic collector**].
f. Power Pack: Dry contacts rated for 20 A [**driver**][**or**][**LED**] load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
g. Mounting:

1) Sensor: Suitable for mounting in any position in a standard device box or outlet box.
2) Relay: Externally mounted through a 1/2 inch (13 mm) knockout in a standard electrical enclosure.
3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

h. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
i. Bypass Switch: Override the "on" function in case of sensor failure.
j. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); turn lights off when selected lighting level is present.
k. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm).

1) Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft (93 sq. m) when mounted on a 96 inch (2440 mm) high ceiling.
2) Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 ft (27.4 m) when mounted on a 10 ft (3 m) high ceiling.
3) Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 sq. ft (110 sq. m)][2000 sq. ft (220 sq. m)][3000 sq. ft (330 sq. m)] when mounted 48 inch (1200 mm) above finished floor.

6. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

B. Ultrasonic Occupancy or Vacancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Lighting Solutions; Signify North America Corp.**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Lutron Electronics Co., Inc**]
e. [**WattStopper; Legrand North America, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Cooper Lighting Solutions; Signify North America Corp.**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Lutron Electronics Co., Inc**]
e. [**WattStopper; Legrand North America, LLC**]
f. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Appliance Controls: UL CCN ATNZ, including UL 60730-1.
b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. [**Wall**][**Ceiling**]-mounted, solid-state indoor [**occupancy**][**and**][**vacancy**] sensors.
b. [**Integrated**][**Separate**] power pack.
c. [**Hardwired**][**Wireless**] connection to switch[**and BAS**][**; and BAS and lighting control system**].
d. Power: Line voltage.
e. Power Pack: Dry contacts rated for 20 A [**driver**][**or**][**LED**] load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
f. Mounting:

1) Sensor: Suitable for mounting in any position in a standard device box or outlet box.
2) Relay: Externally mounted through a **1/2 inch (13 mm)** knockout in a standard electrical enclosure.
3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

g. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
h. Bypass Switch: Override the "on" function in case of sensor failure.
i. Automatic Light-Level Sensor: Adjustable from **2 to 200 fc (21.5 to 2152 lx)**; turn lights off when selected lighting level is present.
j. Detector Sensitivity: Detect a person of average size and weight moving not less than **12 inch (305 mm)** in either a horizontal or a vertical manner at an approximate speed of **12 inch/s (305 mm/s)**.

1) Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of **600 sq. ft (56 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
2) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of **1000 sq. ft (93 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
3) Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of **2000 sq. ft (186 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
4) Detection Coverage (Corridor): Detect occupancy anywhere within **90 ft (27.4 m)** when mounted on a **10 ft (3 m)** high ceiling in a corridor not wider than **14 ft (4.3 m)**.
5) Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [**1000 sq. ft**

(110 sq. m)][2000 sq. ft (220 sq. m)][3000 sq. ft (330 sq. m)] when mounted 84 inch (2100 mm) above finished floor.

6. Operation:

   a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

C. Dual-Technology, Passive-Infrared (PIR) and Ultrasonic, Occupancy or Vacancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Lighting Solutions; Signify North America Corp.**]
   b. [**HLI Solutions; brand of GE Current, a Daintree Company**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper Lighting Solutions; Signify North America Corp.**]
   b. [**HLI Solutions; brand of GE Current, a Daintree Company**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

   a. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
   b. Appliance Controls: UL CCN ATNZ, including UL 60730-1.
   c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

   a. [**Wall**][**Ceiling**]-mounted, solid-state indoor [**occupancy**][**and**][**vacancy**] sensors.
   b. [**Integrated**][**Separate**] power pack.
   c. [**Hardwired**][**Wireless**] connection to switch[**and BAS**][**; and BAS and lighting control system**].
   d. Sensitivity Adjustment: Separate for each sensing technology.
   e. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm), and detect a person of average size and weight moving not less than 12 inch (305 mm) in either a horizontal or a vertical manner at an approximate speed of

12 inch/s (305 mm/s).

1) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft (93 sq. m) when mounted on a 96 inch (2440 mm) high ceiling.
2) Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 sq. ft (110 sq. m)][2000 sq. ft (220 sq. m)][3000 sq. ft (330 sq. m)] when mounted 48 inch (1200 mm) above finished floor.

6. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

D. Dual-Technology, Passive-Infrared (PIR) and Passive-Acoustic, Occupancy or Vacancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HLI Solutions; brand of GE Current, a Daintree Company**]
b. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
c. [**SensorWorx; brand of BLP Technologies, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**HLI Solutions; brand of GE Current, a Daintree Company**]
b. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
c. [**SensorWorx; brand of BLP Technologies, Inc.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
b. Appliance Controls: UL CCN ATNZ, including UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. [**Wall**][**Ceiling**]-mounted, solid-state indoor [**occupancy**][**and**][**vacancy**] sensors.
b. [**Integrated**][**Separate**] power pack.

c. [**Hardwired**][**Wireless**] connection to switch[**and BAS**][**; and BAS and lighting control system**].
d. Sensitivity Adjustment: Separate for each sensing technology.
e. Detector Sensitivity: Detect occurrences of **6 inch (150 mm)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. inch (23 200 sq. mm)**, and detect a person of average size and weight moving not less than **12 inch (305 mm)** in either a horizontal or a vertical manner at an approximate speed of **12 inch/s (305 mm/s)**.

1) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of **1000 sq. ft (93 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
2) Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [**1000 sq. ft (110 sq. m)**][**2000 sq. ft (220 sq. m)**][**3000 sq. ft (330 sq. m)**] when mounted **48 inch (1200 mm)** above finished floor.

6. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

E. Wall-Switch Occupancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Douglas Lighting Controls**]
c. [**Eaton**]
d. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Intermatic, Inc**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
h. [**Lutron Electronics Co., Inc**]
i. [**nLight; Acuity Brands Lighting, Inc.**]
j. [**NSi Industries LLC**]
k. [**Philips; Signify North America; Signify Holding**]
l. [**RAB Lighting**]
m. [**Sensor Switch, Inc**]
n. [**Square D; Schneider Electric USA**]
o. [**WattStopper; Legrand North America, LLC**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Douglas Lighting Controls**]
c. [**Eaton**]
d. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Intermatic, Inc**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
h. [**Lutron Electronics Co., Inc**]
i. [**nLight; Acuity Brands Lighting, Inc.**]
j. [**NSi Industries LLC**]
k. [**Philips; Signify North America; Signify Holding**]
l. [**RAB Lighting**]
m. [**Sensor Switch, Inc**]
n. [**Square D; Schneider Electric USA**]
o. [**WattStopper; Legrand North America, LLC**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Photoelectric Controls: UL CCN WJCT, including UL 773A.
b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in single gang switchbox[**, with provisions for connection to BAS**][**using hardwired connection**][**using wireless connection**].

1) Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2) Operating Ambient Conditions: Dry interior conditions, **32 to 120 deg F (0 to 49 deg C)**.
3) Switch Rating: Not less than 800 VA [**driver**][**or**][**LED**] load at 120 V, 1200 VA [**driver**][**or**][**LED**] load at 277 V, and 800 W incandescent.

b. Standard Range: [**180-degree field of view, field adjustable from 180 to 40 degrees**][**210-degree field of view**]; with a minimum coverage area of [**900 sq. ft (84 sq. m)**][**2100 sq. ft (196 sq. m)**].
c. Sensing Technology: [**PIR**][**Dual technology - PIR and ultrasonic**].
d. Switch Type: [**Single pole.**][**Single pole, dual circuit.**][**Single pole, manual "on," automatic "off."**][**Single pole, field-selectable automatic "on," or manual "on," automatic "off."**]
e. Capable of controlling load in three-way application.
f. Voltage: [**Match circuit voltage**][**120 V**][**277 V**][**Dual voltage - 120 and 277 V**].
g. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from **10 to 150 fc (108 to 1600 lx)**. Switch prevents lights from turning on when light level is higher than set point of sensor.

h. Time Delay:

1) Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
2) Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

i. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
j. Color: [**White**][**Black**]<**Insert color**>.
k. Faceplate: Color matched to switch.

2.6 STORAGE OCCUPANCY SENSORS

A. High-Bay Occupancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**nLight; Acuity Brands Lighting, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**nLight; Acuity Brands Lighting, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Photoelectric Controls: UL CCN WJCT, including UL 773A.

5. Standard Features:

a. Solid-State Unit: Designed to operate with the lamp and ballasts or drivers indicated.
b. Power: Line voltage.

1) Operating Ambient Conditions: **32 to 149 deg F (0 to 65 deg C)**.
2) Mounting: Threaded pipe.
3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
4) Detector Technology: PIR.

c. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from **12 to 50 ft (3.7 to 15.2 m)**.

6. Other Available Features Required for the Project:

    a. HID Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
    b. HID Dimming Adapter: Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor[**and MyzerPORT option**].

7. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
8. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

B. Ceiling-Mounted, Solid-State, Extreme-Temperature Occupancy Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**nLight; Acuity Brands Lighting, Inc.**]
    c. [**Sensor Switch, Inc**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]
    b. [**nLight; Acuity Brands Lighting, Inc.**]
    c. [**Sensor Switch, Inc**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Photoelectric Controls: UL CCN WJCT, including UL 773A.

5. Standard Features:

    a. Operating Ambient Conditions: From **minus 40 to plus 125 deg F (minus 40 to plus 52 deg C)**.
    b. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
    c. Separate Power Pack: Dry contacts rated for 20 A [**driver**][**or**][**LED**] load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
    d. Mounting:

        1) Sensor: Suitable for mounting in any position in a standard device box or outlet box.
        2) Relay: Externally mounted through a **1/2 inch (13 mm)** knockout in a standard electrical enclosure.

3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.

e. Bypass Switch: Override the "on" function in case of sensor failure.
f. Automatic Light-Level Sensor: Adjustable from **2 to 10 fc (21.5 to 108 lx)**; keep lighting off when selected lighting level is present.
g. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.

1) Detector Sensitivity: Detect occurrences of **6 inch (150 mm)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. inch (23 200 sq. mm)**.
2) Detection Coverage (Room): Detect occupancy anywhere in a circular area of **1500 sq. ft (139 sq. m)** when mounted on a **96 inch (2440 mm)** high ceiling.
3) Detection Coverage (High Bay): Detect occupancy within **25 ft (7.6 m)** when mounted on a **25 ft (7.6 m)** high ceiling.

6. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

2.7 OUTDOOR MOTION SENSORS

A. Solid-State Outdoor Motion Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**nLight; Acuity Brands Lighting, Inc.**]
g. [**NSi Industries LLC**]
h. [**RAB Lighting**]
i. [**Sensor Switch, Inc**]
j. [**WattStopper; Legrand North America, LLC**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bryant; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Eaton**]
c. [**Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**nLight; Acuity Brands Lighting, Inc.**]
g. [**NSi Industries LLC**]
h. [**RAB Lighting**]

i. [**Sensor Switch, Inc**]
j. [**WattStopper; Legrand North America, LLC**]
k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.
b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

5. Standard Features:

a. [**PIR**][**Dual-technology (PIR and ultrasonic)**] type, weatherproof. Detect occurrences of **6 inch (150 mm)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. inch (23 200 sq. mm)**.
b. Switch Rating:

1) Luminaire-Mounted Sensor: [**1000 W incandescent, 500 VA fluorescent/LED**]<**Insert rating**>.
2) Separately Mounted Sensor: Dry contacts rated for 20 A [**driver**][**or**][**LED**] load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
3) Switch Type: [**Single pole.**][**Single pole, dual circuit.**][**Single pole, manual "on," automatic "off."**][**Single pole, field-selectable automatic "on," or manual "on," automatic "off."**][**With bypass switch to override the "on" function in case of sensor failure.**]

c. Voltage: [**Match the circuit voltage**][**120 V**][**277 V**][**Dual voltage, 120 and 277 V**] type.
d. Detector Coverage:

1) Standard Range: 210-degree field of view, with a minimum coverage area of **900 sq. ft (84 sq. m)**.
2) Long Range: 180-degree field of view and **110 ft (34 m)** detection range.
3) <**Insert coverage area**>.

e. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from **10 to 150 fc (108 to 1600 lx)**. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
f. Time Delay:

1) Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
2) Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

g. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
h. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from **minus 40 to plus 130 deg F (minus 40 to plus 54 deg C)**, rated as "raintight" in accordance with UL 773A.

2.8 INDUSTRIAL CONTROL SWITCHES

A. Lighting Contactor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Allen-Bradley/Rockwell Automation**]
    c. [**ASCO Power Technologies**]
    d. [**Eaton**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Allen-Bradley/Rockwell Automation**]
    c. [**ASCO Power Technologies**]
    d. [**Eaton**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Industrial Control Switches: UL CCN NRNT, including UL 508.

5. Standard Features:

    a. Electrically operated and [**mechanically**][**electrically**] held, combination-type lighting contactors with [**fusible switch**][**nonfused disconnect**], complying with NEMA ICS 2.
    b. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush driver (driver with 15 percent or less THD of normal load current).
    c. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
    d. Enclosure Rating: Comply with UL 50E.
    e. Provide with control and pilot devices as [**indicated on the Drawings**][**scheduled**], matching the enclosure rating specified for the enclosure.
    f. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.

        1) Monitoring: On-off status, <**Insert monitoring point**>.
        2) Control: On-off operation, <**Insert control point**>.

2.9 EMERGENCY LIGHTING CONTROLS

A. UL FTBR - Automatic Load Control Relay :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bodine; Signify North America; Signify Holding**]
    b. [**Chloride; Signify North America; Signify Holding**]
    c. [**HLI Solutions; brand of GE Current, a Daintree Company**]
    d. [**Intelligent Lighting Controls Inc.**]
    e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
    f. [**nLight; Acuity Brands Lighting, Inc.**]
    g. [**WattStopper; Legrand North America, LLC**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bodine; Signify North America; Signify Holding**]
    b. [**Chloride; Signify North America; Signify Holding**]
    c. [**HLI Solutions; brand of GE Current, a Daintree Company**]
    d. [**Intelligent Lighting Controls Inc.**]
    e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
    f. [**nLight; Acuity Brands Lighting, Inc.**]
    g. [**WattStopper; Legrand North America, LLC**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Emergency Lighting and Power Equipment: UL CCN FTBR, including UL 924.

5. Standard Features:

    a. N.C., electrically held relay.
    b. Coil Rating: [**120**][**277**] V.

B. UL WPWR - Branch Circuit Emergency Lighting Transfer Switch (BCELTS) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bodine; Signify North America; Signify Holding**]
    b. [**Chloride; Signify North America; Signify Holding**]
    c. [**HLI Solutions; brand of GE Current, a Daintree Company**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bodine; Signify North America; Signify Holding**]

b. [**Chloride; Signify North America; Signify Holding**]
c. [**HLI Solutions; brand of GE Current, a Daintree Company**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Automatic Transfer Switches: UL CCN WPWR, including UL 1008.

5. Standard Features:

   a. Automatically transfers emergency lighting load from normal branch circuit to emergency branch circuit in accordance with Article 700 of NFPA 70.
   b. Rating: [**120**][**277**] V, not exceeding 20 A.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [**18 AWG**][**22 AWG**][**24 AWG**]. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [**14 AWG**][**16 AWG**][**18 AWG**]. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 INSTALLATION OF LIGHTING CONTROL DEVICES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.

3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.
3. Installation of Industrial Control Switches: Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.
4. Installation of Wiring:

   a. Conduit: Minimum conduit size is **1/2 inch (13 mm)**.
   b. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's published instructions.
   c. Size conductors in accordance with lighting control device manufacturer's published instructions unless otherwise indicated.
   d. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Interfaces with Other Work:

1. Identification: Provide labels for lighting control devices and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Identify controlled circuits in lighting contactors.
   d. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
   e. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Lighting Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to the Project site during other-than-normal occupancy hours for this purpose. Some of the Work may be required during hours of darkness.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration:

1. [**With assistance from factory-authorized service representatives, demonstrate**][**Demonstrate**] to Owner's maintenance and clerical personnel[**and building occupants**] how to operate the following systems and equipment:

a. Lighting control devices.

B. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain lighting control devices.

3.7 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

a. Upgrade Notice: Not less than [**30 days**]<**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 26 09 23 00A

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Task	Specification	Specification Description
26 09 23 00	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 09 23 00	26 09 00 00	Addressable Luminaire Lighting Controls
26 09 23 00	26 09 00 00a	Relay-Based Lighting Controls
26 09 23 00	26 24 19 00	Motor-Control Centers

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SECTION 26 11 16 00 - SECONDARY UNIT SUBSTATIONS WITH SWITCHBOARD SECONDARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Secondary unit substation equipment.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260513 "Medium-Voltage Cables" for requirements for terminating cables in incoming section of substation.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for requirements for connecting wires.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-[**and wind-**] control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
11. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
12. Section 260913 "Electrical Power Monitoring" specifies remote monitoring of metering instruments and for remote control of circuit breakers and switches.
13. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies field-mounted surge-suppression devices referenced in this Section.

1.2 DEFINITIONS

A. ICCB: Insulated-case circuit breaker.

B. MCCB: Molded-case circuit breaker.

C. PCB: Polychlorinated biphenyl.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

    a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
    b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
    c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

3. Include manufacturer's sample extended warranty language.
4. Include product certificates for secondary unit substations, signed by manufacturer.

B. Shop Drawings: Prepare and submit the following:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Dimensioned plans and elevations showing major components and features.

    a. Include a plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace that accounts for breaker service and removal, and locations of penetrations for grounding and conduits.

4. One-line diagram.
5. List of materials.
6. Nameplate legends.
7. The material, size and number of bus bars, and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
8. Short-time and short-circuit current ratings of secondary unit substations and components.
9. Ratings of individual protective devices.
10. Design Data:

    a. Time-Current Characteristic Curves: For overcurrent protective devices.
    b. Primary Fuses: Submit recommendations and size calculations.
    c. Utility company's metering provisions with indication of approval by utility company.

C. Factory test reports.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for voltage monitoring and adjusting.
4. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

C. Consumable items.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for secondary unit substations requiring approval by <**Insert name of electrical utility**> must be signed by qualified electrical professional engineer responsible for their preparation. [**Obtain approval by electrical utility prior to submitting for action by Architect**][**Submit for action by Architect prior to submitting for approval by electrical utility**].

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

F. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

G. Medium-Voltage Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate medium-voltage cable[**in accordance with electrical utility service provider's requirements**].

1. Medium-voltage cable Installer must be approved by <**Insert name of electrical utility service provider**>.

H. Medium-Voltage Duct Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with installation of medium-voltage duct banks[**in accordance with electrical utility service provider's requirements**].

1. Medium-voltage duct Installer must be approved by <**Insert name of electrical utility service provider**>.

I. Medium-Voltage Equipment Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with hazards and safety requirements associated with installation and operation of medium-voltage equipment[**in accordance with electrical utility service provider requirements**].

1. Medium-voltage equipment Installer must be approved by <**Insert name of electrical utility service provider**>.

J. Electrical Power Monitoring Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.

K. Power Quality Specialist: Recognized experts possessing active NICET Electrical Power Testing (EPT) Technician IV certification and documented experience in power quality testing for installations similar in complexity to the Project.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components[**protected from weather and**] so condensation will not form on or in units. Provide temporary heating in accordance with manufacturer's instructions.

D. Handle secondary unit substation components in accordance with manufacturer's instructions. Use factory-installed lifting provisions.

1.10 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Equipment Service Conditions," "Outdoor Equipment Service Conditions," and "Indoor Equipment Services Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C37 series and IEEE C57 series standards.

1.11 WARRANTY FOR SECONDARY UNIT SUBSTATIONS

A. Special Installer Extended Warranty: Installer warrants that assembled and installed secondary unit substation performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that secondary unit substations performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Description: Medium-voltage, primary incoming section; transformer section; and low-voltage secondary switchgear section; and including coordinated circuit breakers, fusible switches, and metering components.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. General Characteristics:

1. Referenced Standards: IEEE C2 and IEEE C37.121.
2. Indoor Unit Arrangement: Single assembly.
3. Outdoor Unit Arrangement: Single assembly.

    a. Weatherproof, listed for installation outdoors, complying with IEEE C37.20.1.
    b. Aisleless Construction: Full-height doors in front of basic weatherproof equipment.

4. Connections between the primary device and transformer must be [**cable**][**bus**], and between the transformer and secondary must be flexible bus braid unless noted otherwise.
5. Indoor Enclosure: Steel.
6. Outdoor Enclosure: Weatherproof, galvanized steel, listed for installation outdoors, complying with IEEE C37.20.1. Aisleless, full-height doors, with provisions for padlocking, in front of basic weatherproof equipment. Integral structural-steel base frame with factory-applied asphaltic undercoating.
7. Each compartment must have the following features:

    a. Structural design and anchorage adequate to resist loads imposed by [**125 mile/h (200 km/h)**]<**Insert wind speed**> wind.
    b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of each section above expected dew point.
    c. Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
    d. Weatherproof ground-fault circuit interrupter duplex receptacle.
    e. Power for heaters and receptacles must be provided [**by control power transformer**][**as indicated**].
    f. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.

8. Enclosure Finish:

    a. Outdoor Finish: Provide factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
    b. Indoor Finish: Provide factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.
    c. Severe Environment Finish: Provide factory-applied corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of **1/16 inch (1.6 mm)** from the test mark. The

scribed test mark and test evaluation must be conducted in accordance with ASTM D1654, with a rating of not less than 7 arrived at in accordance with Table 1 (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized sheet steel must be coated with a manufacturer's standard zinc-rich paint.

2.4 SECONDARY UNIT SUBSTATION EQUIPMENT

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate secondary unit substation equipment.
c. Factory Tests and Inspections: Perform the following tests and inspections on secondary unit substation equipment, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with the following standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Conduct transformer tests in accordance with IEEE C57.12.90.
2) Conduct primary switchgear tests in accordance with NEMA C37.51.
3) Conduct routine tests of completely assembled switchboard.
4) Resistance measurements of windings on rated voltage connection and on tap extreme connections.
5) Ratios on rated voltage connection and on tap extreme connections.
6) Polarity and phase relation on rated voltage connection.
7) No-load loss at rated voltage on rated voltage connection.
8) Exciting current at rated voltage on rated voltage connection.
9) Impedance and load loss at rated current on rated voltage connection and on tap extreme connections.
10) Applied potential.
11) Induced potential.

2. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kVA Class ONAN or Class AA rating and highest kVA Class ONAF or Class AFA rating.

a. Temperature test is not required if record of temperature test on essentially duplicate unit is available.
b. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

c. Factory Test Reports: Compile and submit factory test and inspection reports.

B. UL YEFV or DLAH or WVGN - Medium-Voltage Terminal Compartment Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]

b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Metal-Clad Switchgear Over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
c. Metal-Enclosed Arc-Resistant Switchgear Over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

a. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG 4 and meeting thermal, mechanical, and dielectric requirements specified for the transformer section.
b. Ratings: Suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.
c. System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

C. UL YEFV or DLAH or WVGN - Medium-Voltage Metal-Enclosed Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Eaton**]
    c. [**Siemens Industry, Inc., Energy Management Division**]
    d. [**Square D; Schneider Electric USA**]
    e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

        1) Articulated Unit Substations: IEEE C37.121.
        2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

    b. Metal-Clad Switchgear Over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
    c. Metal-Enclosed Arc-Resistant Switchgear Over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

    a. Metal-enclosed, air-interrupter switchgear, [**with**][**without**] fuses, complying with IEEE C37.20.3.

        1) Switchgear must be arc-resistant, complying with IEEE C37.20.7, [**Type 1A**][**Type 2A**][**Type 1C**][**Type 2C**].

    b. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.

        1) System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
        2) Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.
        3) Main-Bus Rating: [**600**][**1200**][**2000**] A, continuous.

    c. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

        1) Rating: [**600**][**1200**] A continuous duty and load break.
        2) Two-Time Duty-Cycle Fault Closing: [**25 000**][**40 000**] A, asymmetrical.
        3) Switch Action: No external arc and no significant quantities of ionized gas released into the enclosure.
        4) Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
        5) Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
        6) Protective Shields: Cover live components and terminals.

a) Fuse Mounts: Single-frame mounted and de-energized when switch is open.

7) Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.[**Interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.**]
8) Window: Permits viewing switch-blade positions when door is closed.
9) Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.

d. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading.

1) Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
2) Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.
3) Indicator integral with each fuse to show when it has blown.
4) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

e. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of disconnecting device.

D. UL YEFV or DLAH or WVGN - Medium-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Metal-Clad Switchgear Over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.

c. Metal-Enclosed Arc-Resistant Switchgear Over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

a. Instrument Transformers: Comply with IEEE C57.13.

1) Potential and Current Transformers: Burden and Accuracy Class suitable for connected meters.

b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2) Switch-selectable digital display with the following features:

a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i) Accumulated energy, in **MWh (MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering.
4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three

wire; with three elements, [**15 min**]<**Insert value**> indicating demand register, and provision for testing and adding pulse initiation.

7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with [**15 min**]<**Insert value**> interval.

a) Operation: Counts and records a succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

E. UL YEFV or XPLH - Liquid-Filled Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Siemens Industry, Inc., Energy Management Division**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Siemens Industry, Inc., Energy Management Division**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.
3) Liquid-Immersed Transformers: IEEE C57.12.00.

b. Liquid-Filled Distribution Transformers Over 600 V: UL CCN XPLH, including IEEE C57.12.00 and IEEE C57.12.28.

4. Standard Features:

a. Insulating Liquid:

1) Mineral oil complying with ASTM D3487, Type II, and tested in accordance with ASTM D117.
2) Less flammable, edible-seed-oil based, and listed and labeled by a qualified electrical testing laboratory as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
3) Less flammable, dielectric, and listed and labeled by a qualified electrical testing laboratory as complying with NFPA 70 requirements for fire point of not less than

300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.

4) Less flammable, silicone-based dielectric, and listed and labeled by a qualified electrical testing laboratory as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must have low toxicity and be nonhazardous.

b. Insulation Temperature Rise:

1) 55 deg C, based on an average ambient temperature of **86 deg F (30 deg C)** over 24 hours with a maximum ambient temperature of **104 deg F (40 deg C)**. Insulation system must be rated to continuously allow an additional 12-percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.
2) 65 deg C, based on an average ambient temperature of **86 deg F (30 deg C)** over 24 hours with a maximum ambient temperature of **104 deg F (40 deg C)**.

c. BIL: [**60**][**75**][**95**][**110**] kV.
d. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps[**, two above and two**] below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
e. Cooling System: [**Class ONAN, liquid cooled**][**Class ONAN/ONAF, liquid cooled, and with forced-air rating**][**Class ONAN/ONAF/ONAF, liquid cooled, and with provisions for future forced-air rating**]. Cooling systems must include auxiliary cooling equipment, automatic controls, and status indicating lights.
f. Impedance: <**Insert number**> percent.
g. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers must have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap.[**Include the following additional accessories:**]

1) Liquid-level gage.
2) Pressure-vacuum gage.
3) Liquid temperature indicator.
4) Drain and filter valves.
5) Pressure-relief device.

F. UL YEFV - Dry-Type Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Square D; Schneider Electric USA**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Square D; Schneider Electric USA**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in

accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.
3) Dry-Type Transformers: UL 1562.

4. Standard Features:

a. Primary Incoming Section: Transformer cover-mounted bushings. The bushings must meet thermal, mechanical, and dielectric requirements as specified for the transformer section.
b. Style:

1) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of **104 deg F (40 deg C)**.
2) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], vacuum-pressure, impregnated type, and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of **104 deg F (40 deg C)**.

c. Cooling System:

1) Class AA, air cooled, complying with IEEE C57.12.01.
2) Class AFA, air cooled with forced-air rating, complying with IEEE C57.12.01.

a) Manual forced-air cooling system controls, including manual switch for fans, fan controller and associated power and control wiring, and power panel with current-limiting fuses.
b) Include mounting provision for fans.

3) Class AA/FA, air cooled with provisions for future forced-air rating, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include mounting provision for fans.

4) Class AFA, forced-air cooling, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include cooling fans.

d. Insulation Materials: IEEE C57.12.01, rated [**220**]<**Insert number**> deg C.

1) Insulation Temperature Rise: [**80**][**115**][**150**] deg C, maximum rise above **104 deg F**

(40 deg C).

e. BIL: [**60**][**75**][**95**][**110**] kV.
f. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps[**, two above and two**] below rated primary voltage.
g. Impedance: <**Insert number**> percent.
h. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

G. UL WEVC - Secondary Distribution Section Switchboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Dead-Front Switchboards: UL CCN WEVZ, including UL 891.

      1) Arc Resistance: Annex J of IEEE C37.20.7.

4. Standard Features:

   a. The secondary distribution section must be drawout, [**fused**][**fused where indicated**], low-voltage switchgear, complying with NEMA PB 2.
   b. Switchboard Structure: Front and rear accessible.

      1) Match and align the [**front**][**front and rear**] of the switchgear.
      2) Comply with UL requirements for service entrance equipment.

   c. Switchboard Bus:

      1) Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
      2) Main Phase Bus: Uniform capacity the entire length of section.
      3) Neutral Bus: [**50**][**100**] percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors.

Include braces for neutral-bus extensions for busway feeders.

4) Vertical Section Bus: Extend to spaces for future circuit breakers.
5) Phase- and Neutral-Bus Material:

   a) Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
   b) Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

6) Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size **1/4-by-2 inch (6 by 50 mm)**.
7) Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
8) Neutral Disconnect Link: Bolted, uninsulated, **1/4-by-2 inch (6-by-50 mm)** copper bus, arranged to connect neutral bus to ground bus.

d. Switchboard Arrangement:

1) Main Disconnect Device(s): [**Power circuit breakers**][**Bolted pressure switches**][**ICCBs**][**MCCBs**][**Fusible switches**].
2) Feeder Protective Devices: [**Bolted pressure switches**][**ICCBs**][**MCCBs**][**Fusible switches**].

e. Power Circuit Breakers: [**Fixed**][**Drawout**] mounted, electrically operated air-circuit breakers, complying with UL 1066.

1) With "close" and "open" push buttons and red and green lighted breaker position indicators. Charging time of the motor operator must not exceed 8 seconds. Operator power must be from a control power transformer internal to the switchboard.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that the status of the system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip the circuit breaker when closing on a fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

   a) Adjustable long-delay pickup and time.
   b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
   c) Adjustable instantaneous pickup.
   d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test each trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator LED.

f. Bolted Pressure Switches: Fixed-mounted, manually operated, [**electrically tripped,**][**fusible,**]bolted pressure contact switch. Comply with UL 977.

1) Stored energy deadfront mechanism, compressed and released by the operating handle; switching action must be independent of the speed of the operating handle.
2) Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
3) With fuse clips and fuses for UL 248 Class L time-delay fuses.
4) Electrically tripped switches must include:

    a) Ground-fault protection, with adjustable time delay and test panel.
    b) Single-phase protection, tripping the switch on loss of a source phase.
    c) Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.

g. ICCBs: [**Fixed**][**Drawout**]-mounted, [**manually**][**electrically**] operated air-circuit breakers. Comply with UL 1066.

1) With "close" and "open" push buttons and red and green lighted breaker position indicators. Charging time of the motor operator must not exceed 8 seconds. Operator power must be from a control power transformer internal to the switchboard.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that the status of the system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip the circuit breaker when closing on a fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

    a) Adjustable long-delay pickup and time.
    b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
    c) Adjustable instantaneous pickup.
    d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) With built-in connector to test the breaker settings. Provide one test set.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

h. MCCBs (to 2500 A): Fixed-mounted, manually operated air-circuit breakers. Comply with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by the position of the handle. With manual push-to-trip push button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) With trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs must not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
5) Time-current adjustments to achieve protective-device coordination as follows:

    a) Adjustable long-time delay.
    b) Adjustable short-time setting and delay to shape the time-current curve.

c) Adjustable instantaneous setting.
d) Individually adjustable ground-fault setting and time delay.

6) With built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.[**Provide one test set for testing installed circuit breakers with 225 A frame and higher.**]
7) With built-in digital ammeter display, showing load current and tripping cause.

i. MCCBs (1600 to 2500 A): Fixed-mounted, manually operated air-circuit breakers. Comply with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by the position of the handle. With manual push-to-trip push button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show reasons of automatic trip.
5) Display panel to indicate that the status of the system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip the circuit breaker when closing on a fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.
d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test each trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

j. Fusible Switches: Fixed-mounted, manually operated, [**electrically tripped,**]fusible, quick-make, quick-break switch. Comply with UL 98.

1) Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2) With fuse clips and fuses.
3) Electrically tripped switches must include:

a) Shunt trip.
b) Ground-fault protection, with adjustable time delay and test panel.
c) Single-phase protection, tripping the switch on loss of a source phase.
d) Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.

H. UL YEFV or YEFR - Low-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation Over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Unit Substation Rated 600 V or Less: UL CCN YEFR, including UL 1062.

4. Standard Features:

a. Instrument Transformers: Comply with IEEE C57.13.

1) Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 Accuracy Class of 0.3 with burdens of W, X, and Y.
2) Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.

b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2) Switch-selectable digital display with the following features:

a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i) Accumulated energy, in **MWh** **(MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering.
4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with "off" position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in "off" position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a) Operation: Counts and records a succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

d. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
e. Surge Suppression: Factory installed as an integral part of the low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:

1) Integral disconnect switch.
2) Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3) Indicator light display for protection status.
4) Form-C contacts rated at 5 A and 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5) Surge counter.

f. Control Power Supply: Control power transformer supplying 120 V control circuits through secondary disconnect devices.
g. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1) Flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2) Conductors sized in accordance with NFPA 70 for duty required.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing unit substation equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the**

following:]

1. Spare Fuses: [**Six**]<**Insert number**> of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:

    a. Primary disconnect fuses.
    b. Potential transformer fuses.
    c. Control power fuses.
    d. Fuses and fusible devices for fused circuit breakers.
    e. Fuses for secondary fusible devices.

2. Spare Indicating Lights: Six of each type installed.
3. Spare Mounting Gaskets: [**One**]<**Insert number**> set(s) for bushings, handholes, and the gasket between relief cover and flange of pressure-relief device.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to secondary unit substation equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Racking handle, to manually move circuit breaker between "connected" and "disconnected" positions.
2. Portable test set for testing functions of circuit-breaker, solid-state trip devices without removal from switchboard.
3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
4. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
5. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
6. Storage for Manual: Include rack or holder, near operating instructions, for copy of maintenance manual.

C. Consumable Items: Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

1. Touchup Paint: [**Three**]<**Insert number**> half-pint containers of paint matching enclosure's exterior finish.
2. Primary Switch Contact Lubricant: [**One**]<**Insert number**> container(s).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place. Maximum ground resistance must be 5 Ω at secondary unit substation location.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SECONDARY UNIT SUBSTATION EQUIPMENT

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Commissioning of Electrical Systems: NECA NEIS 90.
6. Hot Work: NFPA 51B.
7. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
8. Life Safety and Means of Egress Work: NFPA 101.
9. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
10. Work in Confined Spaces: NFPA 350.
11. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
12. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
13. Installation of Switchboards: NECA NEIS 400.
14. Installation of Liquid-Filled Transformers: NECA NEIS 410.
15. Installation of Medium-Voltage Switchgear: NECA NEIS 430.
16. AC Outdoor High-Voltage Circuit Breakers: NEMA SG 11.
17. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install secondary unit substations on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic control devices.

D. Interfaces with Other Work:

1. Identification: Provide labels for secondary unit substation equipment and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
d. Install the number of signs required to be readable from each accessible side, but space the signs a maximum of **30 ft (9 m)** apart.
e. Operating Instructions: Place printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures with the maintenance materials.

2. Grounding and Bonding:

a. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not

smaller than 4/0 AWG. Bond surge arrester and neutrals directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors. Keep leads as short as practicable with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.

b. At Exterior Locations:

c. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.

1) Fence and equipment connections must not be smaller than 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding **10 ft (3050 mm)**. Bond each gate section to the fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.

2) Make joints in grounding conductors and loops by exothermic weld or compression connector.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Comply with the provisions of NFPA 70B Ch. 11, "Testing and Test Methods."
2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
3. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation is tested at the specified value or less.
4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
5. Visual and Mechanical Inspection:

a. Verify equipment nameplate data complies with the Contract Documents.

b. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar

bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

E. Switchgear Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and required area clearances.
c. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
d. Verify that fuse and circuit-breaker sizes and types correspond to the Drawings and coordination study as well as the address of the circuit breaker that is used to identify it in microprocessor-communication software.
e. Verify that current and voltage-transformer ratios correspond to the Drawings.
f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
2) Make key exchange with devices operated in off-normal positions.

g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
h. Inspect insulators for evidence of physical damage or contaminated surfaces.
i. Verify correct barrier and shutter installation and operation.
j. Exercise active components.
k. Inspect mechanical indicating devices for correct operation.
l. Verify that filters are in place and vents are clear.
m. Inspect control power transformers as follows:

1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
2) Verify that primary- and secondary-use or circuit-breaker ratings match the Drawings and comply with manufacturer's published instructions.
3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS Table 100.11.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.1.
2) Do not proceed to the dielectric-withstand-voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform a dielectric-withstand-voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

c. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

d. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

e. Verify operation of space heaters.
f. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

F. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify the arresters are clean.
d. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
e. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.

2. Electrical Test:

a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

G. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Verify correct connection of transformers with system requirements.
c. Verify that adequate clearances exist between primary and secondary circuit wiring.
d. Verify the unit is clean.

e. Verify that required grounding and shorting connections provide contact.
f. Verify correct operation of transformer withdrawal mechanism and grounding operation.
g. Verify correct primary- and secondary-fuse sizes for voltage transformers.
h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate the applied voltage, comply with manufacturer's published instructions. Insulation-resistance values of instrument transformers must not be less than values shown in NETA ATS, Table 100.5.
b. Perform a polarity test of each current transformer in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
c. Perform a ratio-verification test using the voltage or current method in accordance with IEEE C57.13.1. Ratio errors must comply with IEEE C57.13.
d. Perform an excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match the curve supplied by the manufacturer or must comply with IEEE C57.13.1.
e. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. The measured burdens must match the instrument transformer Accuracy Class rating.
f. Perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages must comply with NETA ATS, Table 100.5. The insulation-resistance value must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
g. Perform dielectric-withstand-voltage tests on the primary winding with the secondary grounded. Test voltages must comply with NETA ATS, Table 100.9. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application, the primary winding is considered to have passed the test.
h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with test equipment manufacturer's published data.
i. Verify that current-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

3. Electrical Tests of Voltage and Potential Transformers:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply the test voltage for one minute in accordance with NETA ATS, Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's published instructions. Insulation-resistance values of instrument transformers must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages must be applied for one minute in accordance with NETA ATS, Table 100.5. Insulation-resistance values of the transformers must not be less than values shown in NETA ATS, Table 100.5.
c. Perform a polarity test on each transformer to verify the polarity marks or H(1)- X(1) relationship. Polarity results must agree with transformer markings.
d. Perform a turns-ratio test on tap positions. Ratio errors must not exceed the tolerances specified in IEEE C57.13.

e. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared to instrument transformer ratings. The measured burdens must match the instrument transformer Accuracy Class rating.
f. Perform a dielectric-withstand-voltage test on the primary windings with the secondary windings connected to ground. The dielectric voltage must comply with NETA ATS, Table 100.9. The test voltage must be applied for one minute. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the primary windings are considered to have passed the test.
g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with test equipment manufacturer's published data.
h. Verify that voltage-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

H. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean the front panel and remove foreign material from the case.
e. Check tightness of connections.
f. Verify that the frame is grounded in accordance with manufacturer's instructions.
g. Set the relay in accordance with results in Section 260573 "Power System Studies."
h. Download settings from the relays. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to the grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
c. Functional Operation: Check functional operation of each element used in the protection scheme.

I. Liquid-Filled Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect impact recorder prior to unloading.
c. Test dew point of tank gases if applicable.
d. Inspect anchorage, alignment, and grounding.
e. Verify the presence of PCB content labeling.
f. Verify removal of shipping bracing after placement.
g. Verify the bushings are clean.
h. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
i. Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection.
j. Verify that liquid level in tanks and bushings is within manufacturer's published tolerances.

k. Perform specific inspections and mechanical tests recommended by the manufacturer.
l. Verify presence of transformer surge arresters and that their ratings are as specified.
m. Verify that as-left tap connections are as specified.
n. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
c. Measure core insulation resistance at 500 V(dc) if the core is insulated and the core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
e. Perform turns-ratio tests at tap positions. Turns-ratio test results must not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
f. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
g. Measure the resistance of each winding at each tap connection, and record temperature-corrected winding-resistance values in the Operations and Maintenance Manual.
h. Perform an applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9.
i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
j. Remove a sample of insulating liquid in accordance with ASTM D923. Insulating liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

1) Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
2) Acid Neutralization Number: ASTM D974.
3) Specific Gravity: ASTM D1298.
4) Interfacial Tension: ASTM D971.
5) Color: ASTM D1500.
6) Visual Condition: ASTM D1524.
7) Water in Insulating Liquids: ASTM D1533.
8) Power Factor or Dissipation Factor: ASTM D924.

k. Remove a sample of insulating liquid in accordance with ASTM D923 and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

J. Small Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that shipping brackets have been removed.
d. Verify the unit is clean.

e. Perform specific inspections and mechanical tests recommended by the manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index must not be less than 1.0.
b. Perform turns-ratio tests at tap positions. The test results must not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
c. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

K. Large Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that shipping brackets have been removed.
d. Verify the unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by the manufacturer.
h. Verify that as-left tap connections are as specified.
i. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with the test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:

1) 2.0 percent for power transformers.
2) 5.0 percent for distribution transformers.
3) Measure core insulation resistance at 500 V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).

c. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent must be investigated.
d. Perform turns-ratio tests at tap positions. The test results must not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
e. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
f. Measure the resistance of each winding at each tap connection.

g. Perform an applied-voltage test on high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9. The AC dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for one-minute duration. The dc dielectric-withstand-voltage test result must not exceed 100 percent of the AC RMS test voltage specified in IEEE C57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
h. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

L. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that maintenance devices are available for servicing and operating the breaker.
d. Verify the unit is clean.
e. Verify that the arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings in accordance with coordination study provided by end user.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published instructions must be investigated.
b. Measure contact resistance across each power contact of the circuit breaker. Drop values for μΩ or mV(dc) must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Determine long-time pickup and delay by primary current injection. Long-time pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times must not exceed the value shown in NETA ATS, Table 100.7.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and the trip characteristic must not exceed manufacturer's

published time-current tolerance band.

e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band.
f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils must conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
j. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.
k. Verify operation of charging mechanism. The charging mechanism must operate in accordance with manufacturer's published data.

M. Insulated-Case/Molded-Case Air-Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage and alignment.
c. Verify the unit is clean.
d. Operate the circuit breaker to ensure smooth operation.
e. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
f. Perform adjustments for final protective-device settings in accordance with the coordination study. Set the protective devices in accordance with coordination study report.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published instructions must be investigated.
b. Perform a contact/pole-resistance test. Drop values for μΩ or mV(dc) must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Determine long-time pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band, including adjustment factors.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band.
e. Determine ground-fault pickup and time delay by primary current injection. Ground-fault pickup values must be as specified, and the trip characteristic must not exceed manufacturer's published time-current tolerance band.

f. Determine instantaneous pickup by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils must conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.
j. Verify operation of charging mechanism. The charging mechanism must operate in accordance with manufacturer's published data.

N. Low-Voltage Ground-Fault Protection System Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect the components for damage and errors in polarity or conductor routing.

1) Verify that ground connection is made on the source side of the neutral disconnect link and on the source side of ground-fault sensor.
2) Verify that the neutral sensors are connected with correct polarity on both primary and secondary.
3) Verify that phase conductors and the neutral pass through the sensor in the same direction for zero sequence systems.
4) Verify that grounding conductors do not pass through zero sequence sensors.
5) Verify that grounded conductor is solidly grounded.

b. Verify the unit is clean.
c. Operate the circuit breaker to ensure smooth operation.
d. Verify correct operation of functions of the self-test panel if provided.
e. Verify that the control power transformer has adequate capacity for the system.
f. Set pickup and time-delay settings. Record appropriate operation and test sequences in accordance with Section 230.95 "Ground-Fault Protection of Equipment" of NFPA 70.

2. Electrical Tests:

a. Measure the system neutral-to-ground insulation resistance with the neutral disconnect link temporarily removed. Replace the neutral disconnect link after testing. System neutral-to-ground insulation resistance must be a minimum of 1 MΩ. Correct wiring until the minimum is achieved.
b. Perform ground-fault protective-device pickup tests using primary injection. Results of pickup test must be greater than 90 percent of the ground-fault protective-device pickup setting and less than 1200 A or 125 percent of the pickup setting, whichever is smaller. Adjust or replace the device until these parameters are achieved.
c. For summation-type systems utilizing phase and neutral current transformers, verify correct polarities by applying current to each phase-neutral current-transformer pair. This test also applies to MCCBs utilizing an external neutral current transformer. The ground-fault protective device must operate when current direction is the same relative to polarity marks in the two current transformers. The ground-fault protective device must not operate when current direction is opposite relative to polarity marks in the two current transformers.

d. Measure time delay of the ground-fault protective device at a value equal to or greater than 150 percent of the pickup value. Relay timing must be in accordance with manufacturer's published data but must be no longer than one second at 3000 A in accordance with Section 230.95 "Ground-Fault Protection of Equipment" of NFPA 70.
e. Verify reduced control voltage tripping capability is 55 percent for AC systems and 80 percent for DC systems. Replace the ground-fault system if the reduced control voltage tripping requirement is not achieved, and retest.
f. Verify blocking capability of zone interlock systems. Results of zone-blocking tests must be in accordance with manufacturer's published data and design specifications.

O. Metering Device Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
c. Verify the unit is clean.
d. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

a. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
b. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
c. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
d. Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results must confirm the integrity of the secondary circuits of current and voltage transformers.

P. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

Q. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

R. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain secondary unit substation equipment.

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.7 PROTECTION

A. After installation, protect secondary unit substation equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.
b. Rebalance loads.
c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Field Reports for Voltage Monitoring and Adjusting:

    a. Prepare a written report covering monitoring performed and corrective action taken.
    b. For each relay and adjustable circuit breaker, tag the device with adjusting technician's initials and the date of the adjustment. Record the settings and file with test records specified in "Field Quality Control" Article.

B. Infrared Scanning of Secondary Unit Substation Equipment: Perform the survey during periods of maximum possible loading. Remove covers prior to the inspection. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the unit substation.
2. Follow-On Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
3. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. Provide documentation of device calibration.
4. Field Reports for Infrared Scanning: Prepare a certified report that identifies the testing technician and equipment used, and lists the results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between the area of concern and the reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of the deficient area.

5. Act on inspection results in accordance with the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

C. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**one year**]<**Insert duration**> period for full maintenance by [**skilled employees of secondary unit substation equipment Installer**][**manufacturer's authorized service representative**]. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper secondary unit substation equipment operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

END OF SECTION 26 11 16 00

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SECTION 26 11 16 00A - SECONDARY UNIT SUBSTATIONS WITH MOTOR CONTROL CENTER SECONDARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Secondary unit substation equipment.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
6. Section 260513 "Medium-Voltage Cables" for requirements for terminating cables in incoming section of substation.
7. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for requirements for connecting wires.
8. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
9. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
10. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic[**and wind**] control devices referenced by this Section.
11. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
12. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
13. Section 260913 "Electrical Power Monitoring" specifies remote monitoring of metering instruments and for remote control of circuit breakers and switches.
14. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies field-mounted surge-suppression devices referenced in this Section.

1.2 DEFINITIONS

A. Combination Motor Controller: A combination motor-control unit that includes externally operable circuit-disconnecting means, branch-circuit overcurrent protection, and a motor controller with associated auxiliary devices when used.

B. CPT: Control power transformer.

C. ICCB: Insulated-case circuit breaker.

D. MCCB: Molded-case circuit breaker.

E. MCP: Motor-circuit protector.

F. PCB: Polychlorinated biphenyl.

G. SCR: Silicon controlled rectifier.

H. SPD: Surge protection device.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For unit substation. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

    a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
    b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
    c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

3. Include manufacturer's sample extended warranty language.
4. Include product certificates for secondary unit substations, signed by manufacturer.

B. Shop Drawings: Prepare and submit the following:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Dimensioned plans and elevations showing major components and features.

    a. Include plan view and cross section of equipment base, showing clearances, manufacturer's published instructions for minimum workspace clearances that account for breaker service and removal, and locations of penetrations for grounding and conduits.

4. One-line diagram.
5. List of materials.
6. Nameplate legends.
7. Material, size and number of bus bars, and current rating for buses, including mains and branches of phase, neutral, and ground buses.
8. Short-time and short-circuit current ratings of secondary unit substations and components.
9. Ratings of individual protective devices.
10. For motor-control secondary section, submit manufacturer's standard drawings complying with requirements of UL 845.

    a. Manufacturer's production drawings as defined in UL 845.
    b. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for installed controllers.
    c. Nameplate legends.
    d. Vertical and horizontal bus capacities.
    e. Features, characteristics, ratings, and factory settings of installed units.
    f. <**Insert required information**>.

11. Design Data:

    a. Time-Current Characteristic Curves: For overcurrent protective devices.
    b. Primary Fuses: Submit recommendations and size calculations.
    c. Utility company's metering provisions with indication of approval by utility company.

C. Factory test reports.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. For motor-control secondary section, submit the following:

1. Manufacturer's approval drawings as defined in UL 845.
2. Manufacturer's custom drawings as defined in UL 845.
3. Manufacturer's production drawings as defined in UL 845.

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

3. Field reports for voltage monitoring and adjusting.
4. Field reports for infrared scanning.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

C. Consumable items.

1.8 REGULATORY AGENCY APPROVALS

A. Submittals for secondary unit substations requiring approval by <**Insert name of electrical utility**> must be signed by qualified electrical professional engineer responsible for their preparation. [**Obtain approval by electrical utility prior to submitting for action by Architect**][**Submit for action by Architect prior to submitting for approval by electrical utility**].

1.9 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

F. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

G. Medium-Voltage Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate medium-voltage cable[**in accordance with electrical utility service provider's requirements**].

1. Medium-voltage cable Installer must be approved by <**Insert name of electrical utility service provider**>.

H. Medium-Voltage Duct Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with installation of medium-voltage duct banks[**in accordance with electrical utility service provider's requirements**].

1. Medium-voltage duct Installer must be approved by <**Insert name of electrical utility service provider**>.

I. Medium-Voltage Equipment Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with hazards and safety requirements associated with installation and operation of medium-voltage equipment[**in accordance with electrical utility service provider requirements**].

1. Medium-voltage equipment Installer must be approved by <**Insert name of electrical utility service provider**>.

J. Electrical Power Monitoring Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.

K. Power Quality Specialist: Recognized experts possessing active NICET Electrical Power Testing (EPT) Technician IV certification and documented experience in power quality testing for installations similar in complexity to the Project.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components[**protected from weather and**] so condensation will not form on or in units. Provide temporary heating in accordance with manufacturer's written instructions.

D. Handle secondary unit substation components in accordance with manufacturer's written instructions. Use factory-installed lifting provisions.

1. Handle MCCs in accordance with NEMA ICS 2.3 and NECA NEIS 402.

1.11 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility

Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Equipment Service Conditions," "Outdoor Equipment Service Conditions," and "Indoor Equipment Services Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C37 series and IEEE C57 series standards.

1.12 WARRANTY FOR SECONDARY UNIT SUBSTATIONS

A. Special Installer Extended Warranty: Installer warrants that assembled and installed secondary unit substation performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that secondary unit substation performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Description: Medium-voltage, primary incoming section; transformer section; and low-voltage MCC section; and including coordinated circuit breakers, fusible switches, and metering components.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. General Characteristics:

1. Referenced Standards: IEEE C2 and IEEE C37.121.
2. Indoor Unit Arrangement: Single assembly, with secondary section MCC complying with [**UL 50E, Type 1**][**UL 50E, Type 1 (gasketed)**][**UL 50E, Type 12**] construction.
3. Outdoor Unit Arrangement: Single assembly.

    a. Weatherproof, listed for installation outdoors, with primary and transformer sections complying with IEEE C37.20.1, and MCC section complying with UL 50E, Type 3R.
    b. Aisleless Construction: Full-height doors in front of basic weatherproof equipment.

4. Connections between primary device and transformer must be [**cable**][**bus**], and between transformer and secondary must be flexible bus braid unless noted otherwise.
5. Indoor Enclosure: Steel.
6. Outdoor Enclosure: Weatherproof, galvanized steel, listed for installation outdoors, complying with IEEE C37.20.1. Aisleless, full-height doors, with provisions for padlocking, in front of basic weatherproof equipment. Integral structural-steel base frame with factory-applied asphaltic undercoating.

    a. Compartments must have the following features:

        1) Structural design and anchorage adequate to resist loads imposed by [**125 mph (200 km/h)**]<**Insert wind speed**> wind.
        2) Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of section above expected dew point.
        3) Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
        4) Weatherproof ground-fault circuit interrupter (GFCI) duplex receptacle.
        5) Power for heaters and receptacles must be provided [**by control power transformer**][**as indicated on the Drawings**].
        6) Skid Mounted: Mount shipping group on integral base frame as complete weatherproof unit.

7. Unit Substation Enclosures Finish:

    a. Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
    b. Factory-applied finish in manufacturer's standard gray over rust-inhibiting primer on treated metal surface.
    c. Factory-applied corrosion-resistant finish in manufacturer's standard color that withstands [**120 h**][**480 h**] of exposure to salt spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to metal surface in excess of **1/16 inch (1.6 mm)** from test mark. Scribed test mark and test evaluation must be in accordance with ASTM D1654, with rating of not less than 7, in accordance with Table 1 (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized

sheet steel must be coated with manufacturer's standard zinc-rich paint.

2.4 SECONDARY UNIT SUBSTATION EQUIPMENT

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate secondary unit substation equipment.
c. Factory Tests and Inspections: Perform the following tests and inspections on secondary unit substation equipment, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with the following standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Conduct transformer tests in accordance with IEEE C57.12.90.
2) Conduct primary switchgear tests in accordance with NEMA C37.51.
3) Conduct routine tests of completely assembled MCC, including the following:

a) Dielectric Tests: Comply with NEMA ICS 1.
b) Verify correct operation of circuit breaker,[**motor circuit protector,**] magnetic contactor, and control devices, accessories and indicating lamps. Verification checks must be made at rated voltage with power supplies to main buses.
c) Verify correct operation of magnetic contactors with power at 90 percent of rated voltage.

4) Resistance measurements of windings on rated voltage connection and on tap extreme connections.
5) Ratios on rated voltage connection and on tap extreme connections.
6) Polarity and phase relation on rated voltage connection.
7) No-load loss at rated voltage on rated voltage connection.
8) Exciting current at rated voltage on rated voltage connection.
9) Impedance and load loss at rated current on rated voltage connection and on tap extreme connections.
10) Applied potential.
11) Induced potential.

2. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kVA Class ONAN or Class AA rating and highest kVA Class ONAF or Class AFA rating.

a. Temperature test is not required if record of temperature test on essentially duplicate unit is available.
b. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

c. Factory Test Reports: Compile and submit factory test and inspection reports.

B. UL YEFV or DLAH or WVGN - Medium-Voltage Terminal Compartment Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

      1) Articulated Unit Substations: IEEE C37.121.
      2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

   b. Metal-Clad Switchgear over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
   c. Metal-Enclosed Arc-Resistant Switchgear over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

   a. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG 4 and meeting thermal, mechanical, and dielectric requirements specified for transformer section.
   b. Ratings: Suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.
   c. System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
   d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

C. UL YEFV or DLAH or WVGN - Medium-Voltage Metal-Enclosed Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Metal-Clad Switchgear over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
c. Metal-Enclosed Arc-Resistant Switchgear over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

a. Metal-enclosed, air-interrupter switchgear, [**with**][**without**] fuses, complying with IEEE C37.20.3.

1) Switchgear must be arc-resistant, complying with IEEE C37.20.7, [**Type 1A**][**Type 2A**][**Type 1C**][**Type 2C**].

b. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.

1) System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
2) Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.
3) Main-Bus Rating: [**600 A**][**1200 A**][**2000 A**], continuous.

c. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

1) Rating: [**600 A**][**1200 A**] continuous duty and load break.
2) Two-Time Duty-Cycle Fault Closing: [**25 000 A(asym)**][**40 000 A(asym)**].
3) Switch Action: No external arc and no significant quantities of ionized gas released into enclosure.
4) Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
5) Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
6) Protective Shields: Cover live components and terminals.

    a) Fuse Mounts: Single-frame mounted and de-energized when switch is open.

7) Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.[**Interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.**]
8) Window: Permits viewing switch-blade positions when door is closed.
9) Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.

d. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading.

1) Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
2) Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.
3) Indicator integral with fuse to show when it has blown.
4) Spares: Include three fuses in use and three spare fuses in storage clips in switch.

e. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of disconnecting device.

D. UL YEFV or DLAH or WVGN - Medium-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Eaton**]
    c. [**Siemens Industry, Inc., Energy Management Division**]
    d. [**Square D; Schneider Electric USA**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

      1) Articulated Unit Substations: IEEE C37.121.
      2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

   b. Metal-Clad Switchgear over 1000 V: UL CCN DLAH, including IEEE C37.20.2 and NEMA C37.55.
   c. Metal-Enclosed Arc-Resistant Switchgear over 1000 V: UL CCN WVGN, including IEEE C37.20.3 and IEEE C37.20.7.

4. Standard Features:

   a. Instrument Transformers: Comply with IEEE C57.13.

      1) Potential and Current Transformers: Burden and Accuracy Class suitable for connected meters.

   b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

      1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
      2) Switch-selectable digital display with the following features:

         a) Phase Currents, Each Phase: Plus or minus 1 percent.
         b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
         c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
         d) Three-Phase Real Power: Plus or minus 2 percent.
         e) Three-Phase Reactive Power: Plus or minus 2 percent.
         f) Power Factor: Plus or minus 2 percent.
         g) Frequency: Plus or minus 0.5 percent.
         h) Integrated Demand: Demand interval selectable from 5 to 60 min; plus or minus 2 percent.
         i) Accumulated Energy in MWh (MJ): Plus or minus 2 percent; stored values unaffected by power outages for up to 72 h.

      3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering.
      4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

   c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, [**15 min**]<**Insert duration**> indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with [**15 min**]<**Insert duration**> interval.

d. Operation: Counts and records succession of pulses entering two channels.
e. Housing: Drawout, back-connected case arranged for semiflush mounting.

E. UL YEFV or XPLH - Liquid-Filled Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Siemens Industry, Inc., Energy Management Division**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Siemens Industry, Inc., Energy Management Division**]
   c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

      1) Articulated Unit Substations: IEEE C37.121.
      2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.
      3) Liquid-Immersed Transformers: IEEE C57.12.00.

   b. Liquid-Filled Distribution Transformers over 600 V: UL CCN XPLH, including IEEE C57.12.00 and IEEE C57.12.28.

4. Standard Features:

   a. Insulating Liquid:

      1) Mineral oil complying with ASTM D3487, Type II, and tested in accordance with

ASTM D117.

2) Less flammable, edible-seed-oil based, listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
3) Less flammable, dielectric, listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
4) Less flammable, silicone-based dielectric, listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must have low toxicity and be nonhazardous.

b. Insulation Temperature Rise:

1) 55 deg C, based on average ambient temperature of 30 deg C over 24 h with maximum ambient temperature of 40 deg C. Insulation system must be rated to continuously allow additional 12 percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.
2) 65 deg C, based on average ambient temperature of 30 deg C over 24 h with maximum ambient temperature of 40 deg C.

c. BIL: [**60 kV**][**75 kV**][**95 kV**][**110 kV**].
d. Full-Capacity Voltage Taps:

1) Four nominal 2.5 percent taps, two above and two below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
2) Four nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

e. Cooling System: [**Class ONAN, liquid cooled**][**Class ONAN/ONAF, liquid cooled, and with forced-air rating**][**Class ONAN/ONAF/ONAF, liquid cooled, and with provisions for future forced-air rating**]. Cooling systems must include auxiliary cooling equipment, automatic controls, and status indicating lights.
f. Impedance: <**Insert number**> percent.
g. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers must have steel base and frame allowing use of pipe rollers in any direction, and insulated, low-voltage, neutral bushing with removable ground strap.[**Include the following additional accessories:**]

1) Liquid-level gauge.
2) Pressure-vacuum gauge.
3) Liquid temperature indicator.
4) Drain and filter valves.
5) Pressure-relief device.

F. UL YEFV - Dry-Type Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Square D; Schneider Electric USA**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Square D; Schneider Electric USA**]
c. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.
3) Dry-Type Transformers: UL 1562.

4. Standard Features:

a. Primary Incoming Section: Transformer cover-mounted bushings. Bushings must meet thermal, mechanical, and dielectric requirements as specified for transformer section.
b. Style:

1) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with 80 deg C average winding temperature rise above maximum ambient temperature of 40 deg C.
2) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], vacuum-pressure, impregnated type, and with insulation system rated at 220 deg C with 80 deg C average winding temperature rise above maximum ambient temperature of 40 deg C.

c. Cooling System:

1) Class AA: air cooled, complying with IEEE C57.12.01.
2) Class AFA: air cooled with forced-air rating, complying with IEEE C57.12.01.

a) Manual forced-air cooling system controls, including manual switch for fans, fan controller and associated power and control wiring, and power panel with current-limiting fuses.
b) Include[**mounting provisions for**] cooling fans.

3) Class AA/FA: air cooled with provisions for future forced-air rating, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include mounting provisions for fans.

d. Insulation Materials: IEEE C57.12.01, rated [**220 deg C**]<**Insert deg C**>.

1) Insulation Temperature Rise: [**80 deg C**][**115 deg C**][**150 deg C**] maximum rise above 40 deg C.

e. BIL: [**60 kV**][**75 kV**][**95 kV**][**110 kV**].
f. Full-Capacity Voltage Taps:

1) Four nominal 2.5 percent taps, two above and two below rated primary voltage.
2) Four nominal 2.5 percent taps below rated primary voltage.

g. Impedance: <**Insert number**> percent.

5. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

G. UL NJAV - Secondary Distribution Section MCC :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Motor Control Center: UL CCN NJAV, including UL 845.

4. Standard Features:

a. MCC: Combination motor controllers, complying with NEMA ICS 18.

1) Wiring:

a) NEMA ICS 18, [**Class I**][**Class I-S**], [**Type A**][**Type B, for starters larger than Size 3**][**Type B-D, for starter Size 3 and smaller**][**Type B-T, for starter**

Size 3 and smaller][**Type C**].

b) NEMA ICS 18, [**Class II**][**Class II-S**], [**Type B, for starters larger than Size 3**][**Type B-D, for starter Size 3 and smaller**][**Type B-T, for starter Size 3 and smaller**][**Type C**].

2) Short-Circuit Current Rating for Each Unit: [**Combination series rated**][**Fully rated**]; [**22 kA**][**42 kA**][**65 kA**][**100 kA**]<**Insert kA**>.

3) Short-Circuit Current Rating of MCC: [**Combination series rated**][**Fully rated**] with its main overcurrent device; [**22 kA**][**42 kA**][**65 kA**][**100 kA**]<**Insert kA**>.

b. MCC Structure: Front and rear accessible.

1) Match and align front[**and rear**] of MCC.
2) Comply with UL requirements for service entrance equipment.

c. MCC Bus:

1) Use bus bars to connect compartments and vertical sections. Cable connections are prohibited.
2) Main Phase Bus: Uniform capacity entire length of section.
3) Neutral Bus: [**50**][**100**] percent of phase-bus ampacity, except as indicated on the Drawings. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors.
4) Vertical Section Bus: Extend to spaces for future controllers.
5) Phase- and Neutral-Bus Material:

a) Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
b) Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

6) Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size **1/4 by 2 inch (6 by 50 mm)**.
7) Neutral Disconnect Link: Bolted, uninsulated, **1/4 by 2 inch (6 by 50 mm)** copper bus, arranged to connect neutral bus to ground bus.

d. Power Circuit Breaker: [**Fixed**][**Drawout**] mounted, electrically operated air-circuit breaker. Comply with UL 1066.

1) With "close" and "open" push-buttons and red and green lighted breaker position indicators. Charging time of motor operator must not exceed 8 s. Operator power must be from supply internal to MCC.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that status of system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.

d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator LED.

e. Bolted Pressure Switch: Fixed mounted, manually operated, [**electrically tripped,**][**fusible,**]bolted pressure contact switch. Comply with UL 977.

1) Stored energy deadfront mechanism, compressed and released by operating handle; switching action must be independent of speed of operating handle.
2) Indication whether switch is open or closed, and provisions for padlocking operating handle.
3) With fuse clips and fuses for UL 248 Class L time-delay fuses.
4) Electrically tripped switches must include:

a) Ground-fault protection, with adjustable time delay and test panel.
b) Single-phase protection, tripping switch on loss of source phase.
c) Blown fuse protection, tripping switch on blown fuse, with blown fuse indication.
d) Operator power must be from supply internal to MCC.

f. Insulated Case Circuit Breaker: [**Fixed**][**Drawout**] mounted, [**manually**][**electrically**] operated air-circuit breaker. Comply with UL 1066.

1) With "close" and "open" push-buttons and red and green lighted breaker position indicators. Charging time of motor operator must not exceed 8 s. Operator power must be from supply internal to MCC.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that status of system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.
d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) With built-in connector to test breaker settings. Provide one test set.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

g. MCCB (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by position of handle. With manual

push-to-trip push-button.

2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) With trip-setting dials or interchangeable plugs to establish continuous trip of circuit breaker. Plugs must not be interchangeable between frames, and breaker may not be closed without plug. With neutral ground-fault sensor.
5) Time-current adjustments to achieve protective-device coordination as follows:

    a) Adjustable long-time delay.
    b) Adjustable short-time setting and delay to shape time-current curve.
    c) Adjustable instantaneous setting.
    d) Individually adjustable ground-fault setting and time delay.

6) With built-in connector to test long-time delay, instantaneous, and ground-fault functions of breaker.[**Provide one test set for testing installed circuit breakers 225 A frame and higher.**]
7) With built-in digital ammeter display, showing load current and tripping cause.

h. MCCB (1600 to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by position of handle. With manual push-to-trip push-button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show reasons of automatic trip.
5) Display panel to indicate that status of system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

    a) Adjustable long-delay pickup and time.
    b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
    c) Adjustable instantaneous pickup.
    d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

i. Fusible Switch: Fixed-mounted, manually operated, [**electrically tripped,**]quick-make, quick-break switch. Comply with UL 98.

1) Indication whether switch is open or closed, and provisions for padlocking operating handle.
2) With fuse clips and fuses.
3) Electrically tripped switches must include:

    a) Shunt trip.

b) Ground-fault protection, with adjustable time delay and test panel.
c) Single-phase protection, tripping switch on loss of source phase.
d) Blown fuse protection, tripping switch on blown fuse, with blown fuse indication.
e) Operator power must be from supply internal to MCC.

j. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

1) Configurations: [**Nonreversing**][**and**][**reversing**]<**Insert configuration**>.

k. Reduced-Voltage Magnetic Controllers: Electrically held, NEMA ICS 2, general purpose, Class A; closed transition; adjustable time delay on transition.

1) Configurations: Reduced voltage, electrically held.

a) Wye-Delta Controller: Four contactors, with three-phase starting resistor/reactor bank.
b) Part-Winding Controller: Separate START and RUN contactors, field selectable for one-half or two-thirds winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
c) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; one RUN and two START contactors.

l. Reduced-Voltage, Solid-State Controllers: Comply with UL 508.

1) Description: Integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relays.
2) Application: Suitable for use with NEMA MG 1 Design B, polyphase induction motors.
3) Configuration: [**Standard duty**][**Severe duty**]; [**nonreversible**][**reversible**].
4) Starting Mode: [**Voltage ramping**][**Current limit**][**Torque control**][**Torque control with voltage boost**][**; field selectable**].
5) Stopping Mode: [**Coast to stop**][**Adjustable torque deceleration**][**Adjustable braking**][**; field selectable**].
6) Surge Suppression: Factory installed as integral part of controller, SPD complying with UL 1449 as Type 2, or SPD complying with UL 1449, Type 4, suitable for use in Type 2 application.
7) Bypass Contactor: Operates automatically to bypass SCRs when motor has reached rated speed and full voltage is applied to motor. Solid-state controller protective features must remain active when bypass relay is in bypass mode.

a) Manufacturer's standard product.
b) NEMA ICS 2, general-purpose, Class A contactor, rated to start load across the line.

8) Bypass Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating.[**Provide coil with SPD.**]
9) Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to [**400**]<**Insert number**> percent current limitation for 20 s.

10) SCR Bridge: At least two SCRs per phase, for stable and smooth acceleration [**with**][**without**] external feedback from motor or driven equipment.
11) Keypad: Front accessible; for programming controller parameters, functions, and features; must be manufacturer's standard and include not less than the following functions:

    a) Adjusting motor full-load amperes, as percentage of controller's rating.
    b) Adjusting current limitation on starting, as percentage of motor full-load current rating.
    c) Adjusting linear acceleration and deceleration ramps, in seconds.
    d) Setting initial torque, as percentage of nominal motor torque.
    e) Adjusting torque limit, as percentage of nominal motor torque.
    f) Adjusting maximum start time, in seconds.
    g) Adjusting voltage boost, as percentage of nominal supply voltage.
    h) Selecting stopping mode and adjusting parameters.
    i) Selecting motor thermal-overload protection class between 5 and 30.
    j) Activating and deactivating protection modes.
    k) Selecting or activating communications modes.
    l) <**Insert function**>.

12) Digital display, front accessible; for showing motor, controller, and fault status; must be manufacturer's standard and include not less than the following:

    a) Controller Condition: Ready, starting, running, stopping.
    b) Motor Condition: Amperes, voltage, power factor, power, and thermal state.
    c) Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
    d) <**Insert items**>.

13) Controller Diagnostics and Protection:

    a) Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor overload alarm and trip; settings selectable via keypad.
    b) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
    c) Input isolation contactor that opens when controller diagnostics detect faulted solid-state component, or when motor is stopped.
    d) Shunt trip that opens disconnecting means when controller diagnostics detect faulted solid-state component.
    e) <**Insert items**>.

14) Remote Output Features:

    a) All outputs prewired to terminal blocks.
    b) Form C status contacts that change state when controller is running.
    c) Form C alarm contacts that change state when fault condition occurs.
    d) <**Insert items**>.

15) Optional Features:

    a) Analog output for field-selectable assignment of motor operating characteristics; [**Zero to 10 V(dc)**][**4 to 20 mA(dc)**].

b) [**Two**]<**Insert number**> additional field-assignable Form C contacts for alarm outputs.
c) Full-voltage/BYPASS selector switch. Power contacts must be totally enclosed, double break, and made of silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.

m. Multispeed Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

1) Nonreversing Configuration: [**Consequent pole**][**Two winding**].

a) Two speed, with compelling relays to ensure that motor will start only at low speed.
b) Accelerating timer relays, for properly timed acceleration through speeds lower than that selected.
c) Decelerating timer relays, for automatically timed deceleration through each speed.

2) Reversing Configuration: [**Consequent pole**][**Two winding**].

a) Two speed, with compelling relay to ensure that motor will start only at low speed.
b) Compelling relays must ensure that motor starts only at low speed.
c) Accelerating timer relays, for properly timed acceleration through speeds lower than that selected.
d) Decelerating timer relays, for automatically timed deceleration through each speed.
e) Antiplugging timer relays, for time delay when transferring from FORWARD to REVERSE and back.

n. Controller Disconnect and OCPD:

1) Fusible Disconnecting Means:

a) NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate [**Class J**][**Class L**]<**Insert class**> fuses.
b) Lockable Handle: For three padlocks and interlocks with cover in closed position.
c) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

2) MCP Disconnecting Means:

a) UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
b) Lockable Handle: For three padlocks and interlocks with cover in closed position.
c) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
d) [**N.C.**][**N.O.**] alarm contact that operates only when MCP has tripped.
e) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3) MCCB Disconnecting Means:

a) UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c) Lockable Handle: For three padlocks and interlocks with cover in closed position.
d) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
e) [**N.C.**][**N.O.**] alarm contact that operates only when MCCB has tripped.

4) Molded-Case Switch Disconnecting Means:

a) UL 489, with in-line fuse block for Class J or Class L power fuses (depending on ampere rating), providing interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
b) Lockable Handle: For three padlocks and interlocks with cover in closed position.
c) Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
d) [**N.C.**][**N.O.**] alarm contact that operates only when molded-case switch has tripped.

o. Overload Relays:

1) Melting-Alloy Overload Relays:

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2) Bimetallic Overload Relays:

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

3) Solid-State Overload Relays:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
d) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
e) Analog communication module.

4) [**N.C.**][**N.O.**] isolated overload alarm contact.
5) External overload reset push-button.

p. Control Power:

1) Control Circuits: [**24 V(ac)**][**120 V(ac)**]<**Insert voltage**>; obtained from [**integral CPT, with primary and secondary fuses**]<**Insert source of control power**>, with [**CPT**][**control power source**] of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
2) CPT Spare Capacity: [**50 VA**][**100 VA**][**200 VA**]<**Insert VA**>.

q. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1) Flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2) Conductors sized in accordance with NFPA 70 for duty required.

r. ICCB Feeder Tap Units: [**Fixed**][**Drawout**]-mounted, [**manually**][**electrically**] operated air-circuit breakers. Comply with UL 1066.

1) With "close" and "open" push-buttons and red and green lighted breaker position indicators. Charging time of motor operator must not exceed 8 s. Operator power must be from control power transformer internal to switchboard.
2) Solid-state monitoring and tripping system must provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show cause of automatic trip.
5) Display panel to indicate that status of system circuitry is fully operational, or give fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.
d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) Built-in connector tests breaker settings. Provide one test set.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

s. MCCB Feeder Tap Units (to 2500 A): Fixed-mounted, manually operated air-circuit breakers, complying with UL 489.

1) Include quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by position of handle. Include manual push-to-trip push-button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) Include trip-setting dials or interchangeable plugs to establish continuous trip of circuit breaker. Plugs must not be interchangeable between frames, and circuit breaker may not be closed without plug. With neutral ground-fault sensor.
5) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-time delay.
b) Adjustable short-time setting and delay to shape time-current curve.
c) Adjustable instantaneous setting.
d) Individually adjustable ground-fault setting and time delay.

6) With built-in connector to test long-time delay, instantaneous, and ground-fault functions of breaker.[**Provide one test set for testing installed circuit breakers 225 A frame and higher.**]
7) With built-in digital ammeter and digital display, showing tripping cause.

t. MCCB Feeder Tap Units (1600 to 2500 A): Fixed-mounted, manually operated air-circuit breakers, complying with UL 489.

1) With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by position of handle. With manual push-to-trip push-button.
2) Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
3) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
4) LED indicators or display, with manual reset, to show reasons of automatic trip.
5) Display panel indicates that status of system circuitry is fully operational or gives fault location based on automatic diagnosis.
6) Trip circuit breaker when closing on fault.
7) Time-current adjustments to achieve protective-device coordination as follows:

a) Adjustable long-delay pickup and time.
b) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
c) Adjustable instantaneous pickup.
d) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

8) One test kit to test trip function.
9) Battery backup for informational displays after automatic trip, with battery status indicator.

u. Fusible Switch Feeder Tap Units: Fixed-mounted, manually operated, [**electrically tripped,**]fusible, quick-make, quick-break switch. Comply with UL 98.

1) Indication whether switch is open or closed, and provisions for padlocking operating handle.
2) Include fuse clips and fuses.
3) Electrically tripped switches must include:

a) Shunt trip.
b) Ground-fault protection, with adjustable time delay and test panel.
c) Single-phase protection, tripping switch on loss of source phase.
d) Blown fuse protection, tripping switch on blown fuse, with blown fuse indication.

v. Compartments: Modular; individual [**lift-off**]doors with concealed hinges and quick-captive screw fasteners. Interlocks on units require disconnecting means in off position before door can be opened or closed, except by operating permissive release device.
w. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other

units in MCC. Same-size compartments permit interchangeability and ready rearrangement of units, such as replacing three single units with unit requiring three spaces, without cutting or welding.

x. Wiring Spaces:

1) Vertical wireways in vertical section for vertical wiring to unit compartments; supports to hold wiring in place.
2) Horizontal wireways in [**bottom**][**and**][**top**] of vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

y. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1) Push-Buttons, Pilot Lights, and Selector Switches: [**Heavy**][**Standard**]-duty[**, oiltight**] type.

a) Push-Buttons: [**Covered**][**Lockable**][**Recessed**][**Shielded**][**Shrouded**][**Unguarded**] types; [**maintained**][**momentary**] contact unless otherwise indicated.
b) Pilot Lights: [**Incandescent**][**LED**][**Neon**][**Resistor**][**Transformer**] types; <**Insert color(s)**>[**; push to test**].
c) Selector Switches: [**Rotary**]<**Insert description**> type.

2) Elapsed-Time Meters: Heavy duty with digital readout in hours[**; nonresettable**][**; resettable**].

z. Meters: Panel type, **2 1/2 inch (64 mm)** minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having off position.
aa. [**N.C.**][**N.O.**][**Reversible N.C./N.O.**] contactor auxiliary contact(s).
bb. Control Relays: Auxiliary and adjustable [**pneumatic**][**solid-state**] time-delay relays.
cc. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.
dd. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
ee. Sun shields, installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
ff. Cover gaskets, for UL 50E, Type 1 enclosures.
gg. Terminals, for connecting power-factor correction capacitors to [**line**][**load**] side of overload relays.
hh. Spare control-wiring terminal blocks[**; unwired**][**; wired**].
ii. <**Insert auxiliary device**>.

H. UL YEFV or YEFR - Low-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]

d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Unit Substation over 600 V: UL CCN YEFV, including the following referenced standards:

1) Articulated Unit Substations: IEEE C37.121.
2) Integral Unit Substations: IEEE C37.20.2, IEEE C37.20.3, NEMA C37.55, and NEMA C37.57.

b. Unit Substation Rated 600 V or Less: UL CCN YEFR, including UL 1062.

4. Standard Features:

a. Instrument Transformers: Comply with IEEE C57.13.

1) Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 Accuracy Class 0.3 with burdens of W, X, and Y.
2) Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.

b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2) Switch-selectable digital display with the following features:

a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand, with Demand Interval: Selectable from 5 to 60 min, plus or minus 2 percent.
i) Accumulated energy, in **MWh** **(MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 h.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering.

4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with "off" position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in "off" position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15 min indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15 min interval.

a) Operation: Counts and records succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

d. Surge Suppression: Factory installed as integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:

1) Integral disconnect switch.
2) Internal thermal protection that disconnects SPD before damaging internal suppressor components.
3) Indicator light display for protection status.
4) Form-C contacts rated at 5 A and 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5) Surge counter.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing unit substation equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Spare Fuses: [**Six**]<**Insert number**> of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:

a. Primary disconnect fuses.
b. Potential transformer fuses.
c. Control power fuses.
d. Fuses for secondary fusible devices.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to secondary unit substation equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[

Include the following:]

1. Racking handle, to manually move circuit breaker between "connected" and "disconnected" positions.
2. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
3. Storage for Manual: Include rack or holder, near operating instructions, for copy of maintenance manual.

C. Consumable Items: Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

1. Touchup Paint: [**Three**]<**Insert number**> half-pint containers of paint matching enclosure's exterior finish.
2. Primary Switch Contact Lubricant: [**One**]<**Insert number**> container(s).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place. Maximum ground resistance must be 5 Ω at secondary unit substation location.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SECONDARY UNIT SUBSTATION EQUIPMENT

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Commissioning of Electrical Systems: NECA NEIS 90.
6. Hot Work: NFPA 51B.
7. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
8. Life Safety and Means of Egress Work: NFPA 101.

9. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
10. Work in Confined Spaces: NFPA 350.
11. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
12. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
13. Installation of Liquid-Filled Transformers: NECA NEIS 410.
14. Installation of Medium-Voltage Switchgear: NECA NEIS 430.
15. Installation of Motor Control Centers: NEMA ICS 2.3.
16. AC Outdoor High-Voltage Circuit Breakers: NEMA SG 11.
17. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install secondary unit substations on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic control devices.

D. Interfaces with Other Work:

1. Identification: Provide labels for secondary unit substation equipment and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
   d. Install number of signs required to be readable from accessible side, but space signs maximum of **30 ft (9 m)** apart.
   e. Operating Instructions: Place printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures with maintenance materials.

2. Grounding and Bonding:

   a. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
   b. At Exterior Locations:

      1) For counterpoise use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **24 inch (610 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.
      2) Fence and equipment connections must not be smaller than 4 AWG. Ground fence at gate post and corner post and at intervals not exceeding **10 ft (3 m)**. Bond gate section to fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
      3) Make joints in grounding conductors and loops by exothermic weld or compression connector.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
2. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
3. After installing secondary unit substation but before primary is energized, verify that grounding system measurement at substation does not exceed specified value.
4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
5. Visual and Mechanical Inspection:

    a. Verify equipment nameplate data complies with Contract Documents.
    b. Inspect bolted electrical connections for high resistance using one of the following two methods:

        1) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

E. Switchgear and MCC Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, grounding, and required area clearances.
    c. Verify unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
    d. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study as well as address of circuit breaker that is used to identify it in microprocessor-communication software.
    e. Verify that current and voltage-transformer ratios correspond to Drawings.
    f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

        1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

2) Make key exchange with devices operated in off-normal positions.

g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
h. Inspect insulators for evidence of physical damage or contaminated surfaces.
i. Verify correct barrier and shutter installation and operation.
j. Exercise active components.
k. Inspect mechanical indicating devices for correct operation.
l. Verify that filters are in place and vents are clear.
m. Inspect control power transformers as follows:

1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
2) Verify that primary- and secondary-fuse or circuit-breaker ratings match Drawings and comply with manufacturer's published instructions.
3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

a. Perform DC voltage insulation-resistance tests on bus section, phase-to-phase and phase-to-ground, for 1 min. If temperature of bus is other than plus or minus 20 deg C, adjust resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published recommendations or NETA ATS, Table 100.1.
2) Do not proceed to dielectric withstand-voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform dielectric withstand-voltage test on bus section, phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no published recommendation for this test, it must be conducted to in accordance with NETA ATS, Table 100.2. Apply test voltage for 1 min.

1) If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric withstand-voltage test, test specimen is considered to have passed test.

c. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing primary winding with system voltage.

d. Perform current-injection tests on entire current circuit in section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that minimum current of 1.0 A flows in secondary circuit. Verify correct magnitude of current at device in circuit.
2) Perform current tests by primary injection with magnitudes such that minimum of 1.0 A flows in secondary circuit. Verify correct magnitude of current at device in circuit.

e. Verify operation of space heaters.

f. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from every source.

F. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that arresters are clean.
d. Verify that ground lead on device is individually attached to ground bus or ground electrode.
e. Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

2. Electrical Test:

a. Perform insulation-resistance test on arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in table.
b. Perform watts loss test. Evaluate watts loss values by comparison with similar units and test equipment manufacturer's published data.

G. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Verify correct connection of transformers with system requirements.
c. Verify that adequate clearances exist between primary and secondary circuit wiring.
d. Verify that unit is clean.
e. Verify that required grounding and shorting connections provide contact.
f. Verify correct operation of transformer withdrawal mechanism and grounding operation.
g. Verify correct primary- and secondary-fuse sizes for voltage transformers.
h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Perform insulation-resistance test of current transformer and its secondary wiring with respect to ground at 1000 V(dc) for 1 min. For units with solid-state components that cannot tolerate applied voltage, comply with manufacturer's published instructions. Insulation-resistance values of instrument transformers must not be less than values shown in NETA ATS, Table 100.5.
b. Perform polarity test of current transformer in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
c. Perform ratio-verification test using voltage or current method in accordance with IEEE C57.13.1. Ratio errors must comply with IEEE C57.13.
d. Perform excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match curve supplied by manufacturer or must comply with IEEE C57.13.1.
e. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. Measured burdens must match instrument transformer Accuracy Class rating.
f. Perform insulation-resistance tests on primary winding with secondary grounded. Test

voltages must comply with NETA ATS, Table 100.5. Insulation-resistance value must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5.

g. Perform dielectric withstand-voltage tests on primary winding with secondary grounded. Test voltages must comply with NETA ATS, Table 100.9. If no evidence of distress or insulation failure is observed by end of total time of voltage application, primary winding is considered to have passed test.
h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with substation equipment manufacturer's published data. In absence of substation equipment manufacturer's published data, comply with test equipment manufacturer's published data.
i. Verify that current-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

3. Electrical Tests of Voltage and Potential Transformers:

a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply test voltage for 1 min in accordance with NETA ATS, Table 100.5. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's published instructions. Insulation-resistance values of instrument transformers must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
b. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Test voltages must be applied for 1 min in accordance with NETA ATS, Table 100.5. Insulation-resistance values of transformers must not be less than values shown in NETA ATS, Table 100.5.
c. Perform polarity test on transformer to verify polarity marks or H(1) to X(1) relationship. Polarity results must agree with transformer markings.
d. Perform turns-ratio test on tap positions. Ratio errors must not exceed tolerances specified in IEEE C57.13.
e. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared to instrument transformer ratings. Measured burdens must match instrument transformer Accuracy Class rating.
f. Perform dielectric withstand-voltage test on primary windings with secondary windings connected to ground. Dielectric voltage must comply with NETA ATS, Table 100.9. Test voltage must be applied for 1 min. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric withstand-voltage test, primary windings are considered to have passed test.
g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with substation equipment manufacturer's published data. In absence of substation equipment manufacturer's published data, comply with test equipment manufacturer's published data.
h. Verify that voltage-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

H. Liquid-Filled Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect impact recorder prior to unloading.
c. Test dew point of tank gases if applicable.

d. Inspect anchorage, alignment, and grounding.
e. Verify presence of PCB content labeling.
f. Verify removal of shipping bracing after placement.
g. Verify that bushings are clean.
h. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
i. Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection.
j. Verify that liquid level in tanks and bushings is within manufacturer's published tolerances.
k. Perform specific inspections and mechanical tests recommended by manufacturer.
l. Verify presence of transformer surge arresters and that their ratings are as specified.
m. Verify that as-left tap connections are as specified.
n. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with substation equipment manufacturer's published data. In absence of substation equipment manufacturer's published data, comply with NETA ATS, Table 100.3.
c. Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
e. Perform turns-ratio tests at tap positions. Turns-ratio test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
f. Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows different pattern.
g. Measure resistance of winding at tap connection, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
h. Perform applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9.
i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
j. Remove sample of insulating liquid in accordance with ASTM D923. Insulating liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

1) Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
2) Acid Neutralization Number: ASTM D974.
3) Specific Gravity: ASTM D1298.
4) Interfacial Tension: ASTM D971.
5) Color: ASTM D1500.
6) Visual Condition: ASTM D1524.
7) Water in Insulating Liquids: ASTM D1533.
8) Power Factor or Dissipation Factor: ASTM D924.

k. Remove sample of insulating liquid in accordance with ASTM D923 and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

I. Small Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that shipping brackets have been removed.
d. Verify that unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform turns-ratio tests at tap positions. Test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
c. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

J. Large Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that shipping brackets have been removed.
d. Verify that unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by manufacturer.
h. Verify that as-left tap connections are as specified.
i. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:

1) 2 percent for power transformers.
2) 5 percent for distribution transformers.

c. Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-

up test result exceeding 1 percent must be investigated.

e. Perform turns-ratio tests at tap positions. Test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.

f. Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows different pattern.

g. Measure resistance of winding at tap connection.

h. Perform applied-voltage test on high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9. AC dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for 1 min duration. DC dielectric-withstand-voltage test result must not exceed 100 percent of AC RMS test voltage specified in IEEE 57.12.91, Section 10.2, for 1 min duration. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, test specimen is considered to have passed test.

i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

K. Low-Voltage Motor Controller Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect anchorage, alignment, grounding, and clearances.

b. Verify that unit is clean.

c. Inspect contactors:

1) Verify mechanical operation.

2) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

d. Motor-Running Protection:

1) Verify that overload element rating is correct for its application.

2) If motor-running protection is provided by fuses, verify correct fuse rating.

e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests:

a. [**For contactor and circuit breaker, perform**][**Perform**]insulation-resistance tests for 1 min on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Insulation-resistance values must comply with manufacturer's published data or NETA ATS, Table 100.1. In absence of manufacturer's published data, comply with Table 100.5. Investigate and correct values of insulation resistance less than this table or manufacturer's published instructions.

b. Test circuit breakers as follows:

1) Operate circuit breaker to ensure smooth operation.

2) Perform contact/pole-resistance test. Drop values for μΩ or mV(dc) must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

c. Perform operational tests by initiating control devices. Control devices must perform in accordance with system design requirements.

L. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that maintenance devices are available for servicing and operating breaker.
d. Verify that unit is clean.
e. Verify that arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
h. Perform mechanical operator and contact alignment tests on both breaker and its operating mechanism in accordance with manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings in accordance with coordination study provided by end user.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for 1 min on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published recommendations must be investigated.
b. Measure contact resistance across power contact of circuit breaker. Drop values for μΩ or mV(dc) must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Determine long-time pickup and delay by primary current injection. Long-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times must not exceed value shown in NETA ATS, Table 100.7.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.
e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.
f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must conform to manufacturer's published data. In absence of manufacturer's published data,

comply with NETA ATS, Table 100.20.

i. Measure fuse resistance. Investigate fuse-resistance values that deviate from others by more than 15 percent.

j. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.

k. Verify operation of charging mechanism. Charging mechanism must operate in accordance with manufacturer's published data.

M. Insulated-Case/Molded-Case Air-Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage and alignment.
c. Verify that unit is clean.
d. Operate circuit breaker to ensure smooth operation.
e. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
f. Perform adjustments for final protective-device settings in accordance with coordination study. Set protective devices in accordance with coordination study report.

2. Electrical Tests:

a. Perform insulation-resistance tests for 1 min on each pole, phase-to-phase and phase-to ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published recommendations must be investigated.
b. Perform contact/pole-resistance test. Drop values for μΩ or mV(dc) must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Determine long-time pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band, including adjustment factors.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.
e. Determine ground-fault pickup and time delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.
f. Determine instantaneous pickup by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must conform to manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and

trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.

j. Verify operation of charging mechanism. Charging mechanism must operate in accordance with manufacturer's published data.

N. Low-Voltage Ground-Fault Protection System Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect components for damage and errors in polarity or conductor routing.

1) Verify that ground connection is made on source side of neutral disconnect link and on source side of ground-fault sensor.
2) Verify that neutral sensors are connected with correct polarity on both primary and secondary.
3) Verify that phase conductors and neutral pass through sensor in same direction for zero sequence systems.
4) Verify that grounding conductors do not pass through zero sequence sensors.
5) Verify that grounded conductor is solidly grounded.

b. Verify that unit is clean.
c. Operate circuit breaker to ensure smooth operation.
d. Verify correct operation of functions of self-test panel if provided.
e. Verify that control power transformer has adequate capacity for system.
f. Set pickup and time-delay settings. Record appropriate operation and test sequences in accordance with Section 230.95 "Ground-Fault Protection Equipment" of NFPA 70.

2. Electrical Tests:

a. Measure system neutral-to-ground insulation resistance with neutral disconnect link temporarily removed. Replace neutral disconnect link after testing. System neutral-to-ground insulation resistance must be minimum of 1 MΩ. Correct wiring until minimum is achieved.
b. Perform ground-fault protective-device pickup tests using primary injection. Results of pickup test must be greater than 90 percent of ground-fault protective-device pickup setting and less than 1200 A or 125 percent of pickup setting, whichever is smaller. Adjust or replace device until these parameters are achieved.
c. For summation-type systems utilizing phase and neutral current transformers, verify correct polarities by applying current to phase-neutral current-transformer pair. This test also applies to MCCBs utilizing external neutral current transformer. Ground-fault protective device must operate when current direction is same relative to polarity marks in two current transformers. Ground-fault protective device must not operate when current direction is opposite relative to polarity marks in two current transformers.
d. Measure time delay of ground-fault protective device at value equal to or greater than 150 percent of pickup value. Relay timing must be in accordance with manufacturer's published data but must be no longer than 1 s at 3000 A in accordance with Section 230.95 "Ground-Fault Protection Equipment" of NFPA 70.
e. Verify that reduced control voltage tripping capability is 55 percent for AC systems and 80 percent for DC systems. Replace ground-fault system if reduced control voltage tripping requirement is not achieved, and retest.
f. Verify blocking capability of zone interlock systems. Results of zone-blocking tests must be in accordance with manufacturer's published data and design specifications.

O. Metering Device Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
    c. Verify that unit is clean.
    d. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

    a. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
    b. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
    c. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
    d. Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results must confirm integrity of secondary circuits of current and voltage transformers.

P. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

Q. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

R. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint

splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

   a. How to adjust, operate, and maintain secondary unit substation equipment.

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.7 PROTECTION

A. After installation, protect secondary unit substation equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of secondary unit substation. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than **1 inch/h (25 mm/h)**. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

   a. Adjust transformer taps.
   b. Rebalance loads.
   c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Field Reports for Voltage Monitoring and Adjusting:

   a. Prepare written report covering monitoring performed and corrective action taken.
   b. For relay and adjustable circuit breaker, tag device with adjusting technician's initials and date of adjustment. Record settings and file with test records specified in "Field Quality Control" Article.

B. Infrared Scanning of Secondary Unit Substation Equipment: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection. Take visible light photographs at same

locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of electrical power connections of unit substation.
2. Follow-On Infrared Scanning: Perform additional follow-up infrared scan of switchgear 11 months after date of Substantial Completion.
3. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C. Provide documentation of device calibration.
4. Field Reports for Infrared Scanning: Prepare certified report that identifies testing technician and equipment used, and lists results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

5. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

C. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**one year**]<**Insert duration**> period for full maintenance by [**skilled employees of substation equipment Installer**][**manufacturer's authorized service representative**]. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper substation equipment operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

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SECTION 26 11 16 11 - SECONDARY UNIT SUBSTATIONS WITH SWITCHGEAR SECONDARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Articulated secondary unit substations with switchgear secondary.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260513 "Medium-Voltage Cables" for requirements for terminating cables in substation medium-voltage sections.
5. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for requirements for terminating cables in substation low-voltage sections.
6. Section 260523 "Control-Voltage Electrical Power Cables" for requirements for terminating cables in substation instrumentation sections.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic[**and wind**] control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
11. Section 260573 "Power System Studies" specifies coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
12. Section 262300 "Low-Voltage Switchgear" specifies low-voltage distribution sections referenced by this Section.

1.2 DEFINITIONS

A. NETA ATS: Acceptance testing specification.

B. PCB: Polychlorinated biphenyl.

C. RTD: Resistance temperature detector (IEEE C37.2 Device No. 26).

D. SCR: Silicon-controlled rectifier.

E. SPD: Surge protective device.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

    a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
    b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
    c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

3. Include manufacturer's sample extended warranty language.

B. Factory test reports.

C. Shop Drawings: Prepare and submit the following:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Dimensioned plans and elevations showing major components and features.

    a. Include a plan view and cross section of equipment base, showing clearances, workspace that accounts for breaker service and removal, and locations of penetrations for grounding and conduits in accordance with manufacturer's published instructions.

4. One-line diagram.
5. List of materials.
6. Nameplate legends.
7. The material, size and number of bus bars, and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
8. Short-time and short-circuit current ratings of secondary unit substations and components.
9. Ratings of individual protective devices.
10. Mimic-bus diagram.
11. Utility company's metering provisions with indication of approval by utility company.

D. Time-Current Characteristic Curves: For overcurrent protective devices.

E. Primary Fuses: Submit recommendations and size calculations.

F. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for voltage monitoring and adjusting.
4. Field reports for infrared scanning.
5. Field reports for software and firmware upgrades.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

C. Software and firmware service agreement.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

C. Consumable items.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for secondary unit substations requiring approval by authorities having jurisdiction must be signed by qualified electrical professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical

power system modeling and analysis of electrical safety in accordance with NFPA 70E.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components[**protected from weather and**] so condensation does not form on or in units. Provide temporary heating in accordance with manufacturer's published instructions.

D. Handle secondary unit substation components in accordance with manufacturer's published instructions. Use factory-installed lifting provisions.

1.10 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Environmental Conditions," "Outdoor Conditions," and "Indoor Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C37 series and IEEE C57 series standards.

1.11 WARRANTY FOR SECONDARY UNIT SUBSTATIONS

A. Special Installer Extended Warranty: Installer warrants that assembled and installed secondary unit substation performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that secondary unit substation performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

1.12 WARRANTY FOR BATTERIES

A. Special DC Control System Manufacturer Extended Warranty: Manufacturer warrants that components

of DC control system perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended warranty period.

1. DC Control System Equipment (Excluding Batteries) Extended Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Standard VRLA Batteries:

    a. Initial Extended Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion, full coverage for materials only.
    b. Follow-on Extended Warranty Period: [**Nine**]<**Insert number**> year(s) from date of Substantial Completion, pro-rated coverage for materials only.

3. Premium VRLA Batteries:

    a. Initial Extended Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion, full coverage for materials only.
    b. Follow-on Extended Warranty Period: [**19**]<**Insert number**> year(s) from date of Substantial Completion, pro-rated coverage for materials only.

4. Vented Ni-Cd Batteries:

    a. Initial Extended Warranty Period: [**Five**]<**Insert number**> year(s) from date of Substantial Completion, full coverage for materials only.
    b. Follow-on Extended Warranty Period: [**15**]<**Insert number**> year(s) from date of Substantial Completion, pro-rated coverage for materials only.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

1. Unit Substations over 600 V: UL CCN YEFV, including IEEE C37.121 and the following:

    a. Metal-Clad Switchgear: IEEE C37.20.2 and NEMA C 37.55.
    b. Metal-Enclosed Switchgear: IEEE C37.20.3 and NEMA C 37.57.
    c. Liquid-Filled Transformer: IEEE C57.12.00.
    d. Dry-Type Transformer: UL 1562.

C. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap):

a. Batteries: [**1.0**]<**Insert value**>.
b. Transformers: [**1.0**]<**Insert value**>.
c. Sheet Metal Enclosed Electrical Equipment: [**2.5**]<**Insert value**>.
d. Cabling and Bus Ducts: [**2.5**]<**Insert value**>.

4. Component Response Modification Factor (Rp):

a. Batteries: [**2.5**]<**Insert value**>.
b. Transformers: [**2.5**]<**Insert value**>.
c. Sheet Metal Enclosed Electrical Equipment: [**6.0**]<**Insert value**>.
d. Cabling and Bus Ducts: [**6.0**]<**Insert value**>.

5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

a. Batteries: [**2.5**]<**Insert value**>.
b. Transformers: [**2.5**]<**Insert value**>.
c. Sheet Metal Enclosed Electrical Equipment: [**2.5**]<**Insert value**>.
d. Cabling and Bus Ducts: [**1.5**]<**Insert value**>.

2.2 ARTICULATED SECONDARY UNIT SUBSTATIONS WITH SWITCHGEAR SECONDARY

A. Description: [**Medium-voltage, primary incoming section; transformer section; and low-voltage secondary switchgear section; and including coordinated circuit breakers, fusible switches, and metering components**]<**Insert brief description of desired system, assembly, or equipment**>.

B. Indoor Unit Arrangement: [**Single assembly**][**Separate secondary distribution equipment connected with busway**].

C. Outdoor Unit Arrangement: [**Single assembly**][**Separate secondary distribution equipment connected with busway**].

1. Weatherproof, listed for installation outdoors, complying with IEEE C37.20.1.
2. Aisle-less Construction: Full-height doors in front of basic weatherproof equipment.

D. Selection of Components for Secondary Unit Substation:

1. Source Limitations: Obtain components for secondary unit substation from sources approved by [**manufacturer**][**fabricator**] warranting performance of entire [**system**][**assembly**].
2. Provide the following specified products with the secondary unit substation:

a. Secondary Unit Substation No. 1 :

1) Medium-voltage terminal compartment section .
2) Medium-voltage metal-clad switchgear section .
3) Medium-voltage metal-enclosed switchgear section .
4) Medium-voltage instruments section .
5) Liquid-filled medium-voltage transformer section .
6) Dry-type medium-voltage transformer section .
7) Secondary distribution terminal compartment section .
8) Secondary distribution network protectors section .
9) Secondary distribution low-voltage instrument section .
10) Secondary distribution switchgear section .
11) Secondary Distribution Low-Voltage Distribution Section : As specified in Section 262300 "Low-Voltage Switchgear."

E. General Criteria:

1. Connections between primary device and transformer must be [**cable**][**bus**], and between transformer and secondary must be flexible bus braid unless noted otherwise.
2. Indoor Enclosure: Steel.
3. Outdoor Enclosure: [**Weatherproof, aisle-less construction**][**Weatherproof, sheltered-aisle construction, with interior-lighted walk-in aisle**] for outdoor service. Galvanized-steel, weatherproof construction; integral structural-steel base frame with factory-applied asphaltic undercoating.

    a. Enclosure: [**Flat**][**Downward, rearward sloping**] roof; [**bolt-on rear covers**][**rear hinged doors**] for each section, with provisions for padlocking.
    b. Each compartment must have the following features:

        1) Structural design and anchorage adequate to resist loads imposed by [**125 mph (200 km/h)**]<**Insert wind speed**> wind.
        2) Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by [**thermostats to maintain temperature of each section above expected dew point**][**manual switching of branch-circuit protective device**].
        3) Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
        4) LED lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle
        5) Weatherproof ground-fault circuit interrupter (GFCI) duplex receptacle.
        6) Power for heaters, lights, and receptacles must be provided [**by control power transformer**][**as indicated**].

    c. Weatherproof internal-aisle construction must have the following features:

        1) Common internal aisle of sufficient width to permit protective device withdrawal, disassembly, and servicing in aisle.
        2) Doors: Personnel door at each end of aisle, minimum width of [**30 inch (762 mm)**]<**Insert dimension**>; opening outwards; with panic hardware and provisions for [**padlocking**][**cylinder lock**].
        3) Aisle space heaters operating at one-half or less of rated voltage and thermostatically controlled.
        4) Vapor-proof fluorescent aisle lights with low-temperature ballasts and controlled by wall switch at each entrance.
        5) Emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors
        6) GFCI duplex receptacles, a minimum of two, located in aisle.
        7) Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of [**plus 10 deg F (minus 12 deg C)**]<**Insert temperature**> with outside design temperature of [**minus 20 deg F (minus 29 deg C)**]<**Insert temperature**>.
        8) Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of [**85 deg F (29 deg C)**]<**Insert temperature**> with outside design temperature of [**104 deg F (40 deg C)**]<**Insert temperature**>.
        9) Ventilating openings[**complete with replaceable fiberglass air filters**].
        10) Thermostat: Single stage; wired to control heat and exhaust fan.

4. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.
5. Unit Substation Enclosures Finish:

a. Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
b. Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.
c. Factory-applied corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to salt spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to metal surface in excess of **1/16 inch (1.6 mm)** from test mark. The scribed test mark and test evaluation must be conducted in accordance with ASTM D1654, with a rating of not less than 7 arrived at in accordance with Table 1 (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized sheet steel must be coated with a manufacturer's standard zinc-rich paint.

F. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate secondary unit substation components.
c. Factory Tests and Inspections: Perform the following tests and inspections on secondary unit substation components, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Perform design and routine tests in accordance with standards specified for components. Conduct transformer tests in accordance with IEEE C57.12.90. Conduct switchgear and switchboard tests in accordance with NEMA C 37.51.
2) Perform the following factory-certified tests on each secondary unit substation:

a) Resistance measurements of all windings on rated voltage connection and on tap extreme connections.
b) Ratios on rated voltage connection and on tap extreme connections.
c) Polarity and phase relation on rated voltage connection.
d) No-load loss at rated voltage on rated voltage connection.
e) Exciting current at rated voltage on rated voltage connection.
f) Impedance and load loss at rated current on rated voltage connection and on tap extreme connections.
g) Applied potential.
h) Induced potential.
i) Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kVA Class ONAN or Class AA rating and highest kVA Class ONAF or Class AFA rating. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.

d. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

e. Factory Test Reports: Compile and submit factory test and inspection reports.

G. Medium-Voltage Terminal Compartment Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Eaton**]
    c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
    d. [**Siemens Industry, Inc., Energy Management Division**]
    e. [**Square D; Schneider Electric USA**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Eaton**]
    c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
    d. [**Siemens Industry, Inc., Energy Management Division**]
    e. [**Square D; Schneider Electric USA**]
    f. <**Insert manufacturer's name**>

3. Standard Features:

    a. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG 4 and meeting thermal, mechanical, and dielectric requirements specified for transformer section.
    b. Ratings: Suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.
    c. System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
    d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

H. Medium-Voltage Metal-Clad Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Eaton**]
    c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
    d. [**Siemens Industry, Inc., Energy Management Division**]
    e. [**Square D; Schneider Electric USA**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Eaton**]
    c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]

d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. Metal-clad, circuit-breaker switchgear, complying with IEEE C37.20.2 and NEMA SG 4 and tested for compliance in accordance with NEMA C 37.55.

1) Arc Resistant: Comply with IEEE C37.20.7, [**Type 1**][**Type 2**][**Type 1C**][**Type 2C**].

b. Ratings must comply with IEEE C37.04, suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.

1) System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
2) Nominal Interrupting-Capacity Class: [**250**][**350**][**500**][**750**][**1000**] MVA.
3) Main-Bus Rating: [**1200**][**2000**][**3000**] A, continuous.

c. Circuit Breakers: Electrically operated, drawout mounting; using three individual vacuum-sealed interrupter modules, and including the following features:

1) Designed to operate at rated voltage to interrupt fault current within its rating within [**three**][**five**] cycles of trip initiation. For systems with X/R ratio of 17 or less, transient voltage during interruption must not exceed twice rated line-to-ground voltage of system.
2) Contact-Wear Indicator: Readily accessible to field maintenance personnel.
3) Minimum of six Type A and six Type B spare contacts.
4) Interchangeability: Interchangeable with vacuum circuit breakers of same current and interrupting ratings.
5) Operating Mechanism: Electrically charged, mechanically and electrically trip-free, stored-energy operation.

d. Control Power:

1) [**48**][**125**]<**Insert voltage**> V(dc) for closing and tripping.
2) [**120**][**240**]<**Insert voltage**> V(ac) for closing and tripping.

e. Low-DC-Voltage Alarm: Monitor DC control power voltage with a remote alarm. Alarm must sound if voltage falls to an adjustable value to indicate an impending battery failure. Factory set alarm value at 80 percent of full-charge voltage.
f. Remote-Tripping Device: Wall-mounting emergency control station to open circuit breakers; located in red cast-metal box with break-glass operation.
g. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

I. Medium-Voltage Metal-Enclosed Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]

b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. Metal-enclosed, air-interrupter switchgear, [**with**][**without**] fuses, complying with IEEE C37.20.3.

1) Switchgear must be arc resistant, complying with IEEE C37.20.7, [**Type 1**][**Type 2**][**Type 1C**][**Type 2C**].

b. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60 Hz, solidly grounded-neutral system.

1) System Voltage: [**4.16 kV nominal; 4.76 kV maximum**][**7.2 kV nominal; 15 kV maximum**][**13.8 kV nominal; 15 kV maximum**][**34.5 kV nominal; 38 kV maximum**]<**Insert other voltage**>.
2) Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.
3) Main-Bus Rating: [**600**][**1200**][**2000**] A, continuous.

c. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

1) Rating: [**600**][**1200**] A continuous duty and load break.
2) Two-Time Duty-Cycle Fault Closing: [**25 000**][**40 000**] A, asymmetrical.
3) Switch Action: No external arc and no significant quantities of ionized gas released into enclosure.
4) Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
5) Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
6) Protective Shields: Cover live components and terminals.
7) Fuse Mounts: Single-frame mounted and de-energized when switch is open.
8) Mechanical Interlock: Prevent opening of switch compartment door unless switchblades are open, and prevent closing switch if door is open.[**Interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.**]
9) Window: Permits viewing switchblade positions when door is closed.

4. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, with

ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

J. Medium-Voltage Instruments Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Standard Features:

   a. Instrument Transformers: Comply with IEEE C57.13.

      1) Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 Accuracy Class of 0.3 with burdens of W, X, and Y.
      2) Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.

   b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

      1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
      2) Switch-selectable digital display with the following features:

         a) Phase Currents, Each Phase: Plus or minus 1 percent.
         b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
         c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
         d) Three-Phase Real Power: Plus or minus 2 percent.
         e) Three-Phase Reactive Power: Plus or minus 2 percent.
         f) Power Factor: Plus or minus 2 percent.
         g) Frequency: Plus or minus 0.5 percent.
         h) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
         i) Accumulated energy, in **MWh** **(MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring."
4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, [**15-minute**]<**Insert value**> indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with [**15-minute**]<**Insert value**> interval.

a) Operation: Counts and records a succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

d. Overcurrent and Ground-Fault Protective Relays: Multifunctional, solid-state microprocessor-based, medium-voltage relay, for operation from specified control power. Comply with IEEE C37.90.

1) Field-Selectable Relay Settings: Required by overcurrent protective device coordination study and arc-flash study.
2) Primary Current-Transformer Ratings: Programmable from 5 to 5000 A.
3) Phase and Ground Protection: Field-selectable curves from IEEE moderately inverse, very inverse, or extremely inverse.
4) Phase Instantaneous Overcurrent Trip Pickup Point: Field selectable as "none" or from 1.0 to 25 times current-transformer primary rating. Include discriminator circuit with "on" and "off" switch, so that when phase instantaneous overcurrent has been programmed to "none," discriminator circuit protects against currents exceeding 11 times current-transformer primary rating when breaker is being closed and must be deactivated after approximately eight cycles.
5) Contacts: Two Form A contacts, field selectable into contact pairs as follows and as required by overcurrent protective device coordination study and arc-flash study:

a) One contact assigned IEEE Device No. 51 phase and IEEE Device No. 51 ground, and other contact assigned IEEE Device No. 50 phase and IEEE Device No. 50 ground.
b) One contact assigned IEEE Device No. 51/50 phase, and other contact assigned 51/50 ground.

6) Alphameric display to show the following parameters with metering accuracy not to exceed 2 percent of full scale:

a) Individual phase currents.
b) Ground current.
c) Cause of trip.

d) Magnitude and phase of current causing trip.
e) Phase or ground indication.
f) Peak current demand for each phase and ground since last reset.
g) Current-transformer primary rating.
h) Programmed phase and ground set points.

7) Communications module to transmit the following data in accordance with Section 260913 "Electrical Power Monitoring."

a) Relay's metered and target data, such as currents, set points, cause of trip, magnitude of trip current, and open-close trip status.
b) Ability to close and open associated breaker with proper access code from remote location over communication network when relay is configured in remote open-close mode.

8) Relay alarm and trip contacts must not change state if power is lost or an undervoltage occurs. These contacts must only cause a trip on detection of an overcurrent or fault condition based on programmed settings. Provide a "protection off" alarm, which must be normally energized when relay is powered and self-diagnostics indicates unit is functional. On loss of power or relay failure, this alarm relay must be de-energized providing a fail-safe protection off alarm.
9) The relay must operate reliably solely from breaker main current transformers during a fault condition, if normally connected auxiliary AC voltage is not available, even after an extended power outage.
10) Mount relay in a drawout case with a two-stage quick-release operation. The removal of relay from case must disconnect trip circuits and short current-transformer secondaries before unit control power is disconnected. When relay is inserted into case, control power connections must be made before trip circuits are activated. Include a self-shorting contact on case terminal block to provide alarm indication and tripping of circuit breaker upon removal of relay from case.

e. <**Insert other relay types**>.
f. Control Power Supply Transformer:

1) Control power transformer supplies 120 V control circuits through secondary disconnect devices.

a) Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
b) Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
c) Secondary windings connected through relay(s) to control bus to affect an automatic transfer scheme.
d) Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
e) Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

g. Control Power Supply DC Battery System:

1) System Requirements: Battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at **77 deg F (25 deg C)** with electrolyte at normal level and minimum ambient temperature of **55 deg F (13 deg C)**. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery

to operate ungrounded. Battery system capacity must be in accordance with switchgear manufacturer's published instructions to operate circuit breakers for intended duty.

2) Battery: [**Standard VRLA**][**Premium VRLA**][**Vented Ni-Cd**] batteries, with battery disconnect and overcurrent protective device.

3) Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.[**Rate battery rack, cell supports, and anchorage for seismic requirements.**]

   a) Thermometers with specific-gravity correction scales.
   b) Hydrometer syringes.
   c) Set of cell numerals.

4) Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with AC input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.

   a) DC ammeter.
   b) DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
   c) Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by N.O. push-button contact.
   d) Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
   e) Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.
   f) AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. Automatic charger operation must resume after loss of AC power supply for any interval.
   g) Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. The device must regulate charging current, but must not disconnect charger from either battery or AC supply.
   h) Charger's Audible Noise: Less than 26 dB(A-weighted).

5) Control Wiring: Factory installed, complete with bundling, lacing, and protection.

   a) Conductors across Hinges and for Interconnections between Shipping Units: Flexible conductors for 8 AWG and smaller.
   b) Conductors: Sized in accordance with NFPA 70 for duty required.

K. Liquid-Filled Medium-Voltage Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]

f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. **<Insert manufacturer's name>**

3. Standard Features:

   a. IEEE C57.12.00 [**and UL 1062,**]liquid-filled, two-winding, secondary unit substation transformer.
   b. Primary Incoming Section: Transformer cover-mounted bushings. The bushings must meet thermal, mechanical, and dielectric requirements as specified for transformer section.
   c. Insulating Liquid:

      1) Mineral oil complying with ASTM D3487, Type II, and tested in accordance with ASTM D117.
      2) Less flammable, edible-seed-oil based, and listed and labeled for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
      3) Less flammable, dielectric, and listed and labeled for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic.
      4) Less flammable, silicone-based dielectric, and listed and labeled for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must have low toxicity and be nonhazardous.

   d. Insulation Temperature Rise:

      1) 55 deg C, based on an average ambient temperature of **86 deg F (30 deg C)** over 24 hours with a maximum ambient temperature of **104 deg F (40 deg C)**. Insulation system must be rated to continuously allow an additional 12 percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.
      2) 65 deg C, based on an average ambient temperature of **86 deg F (30 deg C)** over 24 hours with a maximum ambient temperature of **104 deg F (40 deg C)**.

   e. BIL: [**60**][**75**][**95**][**110**][**150**][**200**] kV.
   f. Full-Capacity Voltage Taps:

      1) Four nominal 2.5 percent taps, two above and two below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
      2) Four nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

   g. Cooling System: [**Class ONAN, liquid cooled**][**Class ONAN/ONAF, liquid cooled, and with forced-air rating**][**Class ONAN/OFAF, liquid cooled, and with provisions for future forced-air rating**]. Cooling systems must include auxiliary cooling equipment, automatic controls, and status indicating lights.

h. Impedance: <**Insert number**> percent.

L. Dry-Type Medium-Voltage Transformer Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Standard Features:

   a. IEEE C57.12.01 and IEEE C57.12.51, dry-type, two-winding, secondary unit substation transformer.
   b. Primary Incoming Section: Transformer cover-mounted bushings. The bushings must meet thermal, mechanical, and dielectric requirements as specified for transformer section.
   c. Style:

      1) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of **104 deg F (40 deg C)**.
      2) [**Indoor, ventilated**][**Outdoor, ventilated**][**Totally enclosed, nonventilated**], vacuum-pressure, impregnated type, and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of **104 deg F (40 deg C)**.

   d. Cooling System:

      1) Class AA, air cooled, complying with IEEE C57.12.01.
      2) Class AFA, air cooled with forced-air rating, complying with IEEE C57.12.01.

         a) Manual forced-air cooling system controls, including manual switch for fans, fan controller and associated power and control wiring, and power panel with current-limiting fuses.
         b) Include mounting provision for fans.

      3) Class AA/AFA, air cooled with provisions for future forced-air rating, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include mounting provision for fans.

4) Class AFA, forced-air cooling, complying with IEEE C57.12.01.

a) Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
b) Include cooling fans.

e. Insulation Materials: IEEE C57.12.01, rated [**220**]<**Insert number**> deg C.

1) Insulation Temperature Rise: [**80**][**115**][**150**] deg C maximum rise above **104 deg F (40 deg C)**.

f. BIL: [**60**][**75**][**95**][**110**][**150**][**200**] kV.
g. Full-Capacity Voltage Taps:

1) Four nominal 2.5 percent taps, two above and two below rated primary voltage.
2) Four nominal 2.5 percent taps below rated primary voltage.

h. Impedance: <**Insert number**> percent.
i. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

M. Secondary Distribution Terminal Compartment Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. Low-Voltage Terminal Compartment: Bus [**bars mounted on standoff insulators**][**duct**

flange for close coupling with busway].

N. Secondary Distribution Switchgear Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   d. [**Siemens Industry, Inc., Energy Management Division**]
   e. [**Square D; Schneider Electric USA**]
   f. <**Insert manufacturer's name**>

3. Standard Features:

   a. The secondary distribution section must be drawout, [**fused**][**fused where indicated**], low-voltage switchgear, complying with IEEE C37.20.1 and UL 1558.

      1) Section barriers between main and tie circuit-breaker compartments must be extended to rear of section.

   b. Switchgear Structure:

      1) Match and align front and back of switchgear.
      2) Isolate line bus from load bus at each main and tie circuit breaker with bus isolation barriers.
      3) Allow the following circuit-breaker functions to be performed when compartment door is closed:

         a) Operate manual charging system.
         b) Open and close circuit breaker.
         c) Examine and adjust trip unit.
         d) Read breaker nameplate.

      4) Locate instrumentation transformers within breaker cell, and make front accessible and removable.

   c. Switchgear Bus:

      1) Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
      2) Main Phase Bus: Uniform capacity the entire length of section.

3) Neutral Bus: [**50**][**100**] percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
4) Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
5) Phase- and Neutral-Bus Material:

   a) Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
   b) Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.
   c) Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

6) Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus.
7) Use copper for connecting circuit-breaker line to copper bus.
8) Contact Surfaces of Buses: Silver plated.
9) Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
10) Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size **1/4 by 2 inch (6 by 50 mm)**.
11) Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
12) Neutral Disconnect Link: Bolted, uninsulated, **1/4 by 2 inch (6 by 50 mm)** copper bus, arranged to connect neutral bus to ground bus.
13) Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
14) Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
15) Sprayed Insulation Thickness: **3 mils (0.08 mm)**, minimum.
16) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

d. Circuit-Breaker Compartment:

1) Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in "connected," "test," and "disconnected" positions. Include the following features:

   a) Interlocks: Prevent movement of circuit breaker to or from "connected" position when it is closed, and prevent closure of circuit breaker unless it is in "connected," "test," or "disconnected" position.
   b) Primary Disconnect: Mount on stationary part of compartment. The disconnect must consist of a set of contacts extending to rear through an insulating support barrier, and of corresponding moving finger contacts on power circuit-breaker studs, which engage in only "connected" position. The assembly must provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on each finger. Load studs must connect to bus extensions that terminate in solderless terminals in rear cable compartment.
   c) Secondary Disconnect: Floating terminals mounted on stationary part of compartment that engage mating contacts at front of breaker. Disconnecting devices must be gold plated, and engagement must be maintained in

"connected" and "test" positions.

e. Circuit-Breaker Positioning: Permit racking of an open circuit breaker to or from "connected," "test," and "disconnected" positions only when compartment door is closed unless live parts are covered by a full dead-front shield. Permit manual withdrawal of an open circuit breaker to a position for removal from structure. When compartment door is open, status for connection devices for different positions includes the following:

1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

f. Circuit Breakers:

1) Comply with IEEE C37.13 and UL 1066.
2) Ratings: Continuous, interrupting, and short-time current ratings for each circuit breaker must match voltage and frequency ratings for switchgear.
3) Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

a) Normal Closing Speed: Independent of both control and operator.
b) Slow Closing Speed: Optional with operator for inspection and adjustment.
c) Stored-Energy Mechanism: [**Manually charged**][**Electrically charged**][**Electrically charged, and operator's choice of manual charging**].
d) Operating Handle: One for each circuit breaker capable of manual operation.
e) Electric Close Button: One for each electrically operated circuit breaker.
f) Operation counter.

4) Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

a) Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
b) Temperature compensation that ensures accuracy and calibration stability from **plus 23 to 104 deg F (minus 5 to plus 40 deg C)**.
c) Field-adjustable, time-current characteristics.
d) Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or a combination of these methods.
e) Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."

5) Pickup Points:

a) Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-t operation.
b) Five minimum, for instantaneous-trip functions.

6) Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup.

a) Arrange to provide protection for three-wire circuit or system.
b) Arrange to provide protection for four-wire circuit or system.
c) Arrange to provide protection for four-wire, double-ended substation.

7) Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
8) Auxiliary Contacts:

a) Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.
b) Spare auxiliary switches, at least two, unless other quantity is indicated. Each switch must consist of two Type A and two Type B contacts wired through secondary disconnect devices to a terminal block in stationary circuit-breaker compartment.

9) Arc Chutes: Readily removable from associated circuit breaker when it is in "disconnected" position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
10) Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

g. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
h. Key Interlocks: Arranged to prevent opening or closing interlocked circuit breakers, except in a specified sequence. Include mountings and hardware for future installation of key interlocks.
i. Undervoltage Trip Devices:

1) Instantaneous, with adjustable pickup voltage.
2) Adjustable time-delay and pickup voltage.

j. Shunt-trip devices.
k. Fused Circuit Breakers: Circuit-breaker and fuse combinations complying with requirements for circuit breakers and trip devices.

1) Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
2) Circuit Breakers with Frame Size [**1600**]<**Insert number**> A and Smaller: Mount fuses on line side of associated circuit breaker[**, on a common drawout carriage**], arranged so fuses are accessible only when circuit breaker is in "disconnected" position.
3) Circuit Breakers with Frame Sizes More than [**1600**]<**Insert number**> A: Fuses and circuit breakers [**may**][**must**] be installed in separate compartments on separate drawout mountings. Interlock fuse drawout element with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in "open" position.
4) Open-Fuse Trip Device: Provide for a positive means of tripping and holding circuit breaker in "open" position when a fuse opens. Indicate open-fuse status [**at front of circuit breaker**][**or**][**fuse drawout element**].

l. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

O. Secondary Distribution Network Protectors Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. The secondary distribution section must be composed of drawout, fused, low-voltage network protectors, complying with IEEE C57.12.44 and IEEE C37.20.1. The switch must comply with UL 1066.

1) Rated for continuous service in an ambient temperature of up to **104 deg F (40 deg C)**, applied to three-phase, four-wire, solidly grounded wye secondary networks. Comply with IEEE C57.12.44.
2) Dead-front, drawout design with externally mounted fuses, using hand-cranked rail system. Include mechanical interlocks to prevent racking in and racking out when protector is closed.
3) Locate relay and control panel on a separate drawout module.
4) Protector Operator: [**Spring-close**][**and**][**or**][**stored-energy**] mechanism, rated to close on a [**25 000**][**40 000**] A RMS symmetrical load.
5) Control Voltage: 125 V.
6) Program relay with factory default values. Provide one hand-held pendant to field adjust these values using relay calibration procedures. Include an anti-pumping program to lock protector open under abnormal conditions.
7) Include current-limiting fuses on network side of protector for protection against switchboard bus faults.

b. Coordinate and comply with requirements of low-voltage switchgear supplied by network.
c. Controls: Microprocessor-based, three-phase network relay, with features and functions as follows:

1) The protector control must use a positive and negative sequence-based algorithm for current and voltage.
2) Close protector if positive sequence power flows into network. Adjustable closing range must be from 0.5 to 3.5 V in phase difference between network and transformer voltages.
3) Trip protector if there is a net, three-phase, reverse power flow through protector. Trip protectors must be adjustable from 0.05 to 5 percent of continuous-current rating of current transformers within protector.
4) Trip protector if there is a flow of reverse magnetizing current to its associated transformer.
5) Relay parameters and watt or watt-var trip values must be field adjustable.
6) Protector must not open under any fault on network side of protector.

7) Include auxiliary contacts and control wiring for use with remote pilot devices that provide remote trip and lockout functions in low-voltage switchgear. Include [**two**]<**Insert number**> spare auxiliary contacts and an equal number of N.O. and N.C. types.

d. Network Communications: Data and digital data-transmission interface must be compatible with system specified in Section 260913 "Electrical Power Monitoring." Communicate the following network relay parameters:

1) Current in each phase.
2) Phase-to-phase and phase-to-neutral voltages.
3) Three-phase watts, VARs, and VA.
4) Frequency.
5) Power factor.
6) Network relay set points.

e. Enclosure:

1) With top-mounted transition to connect to low-voltage power network.
2) Network Switchgear-Mounted Disconnect Switch:

a) Supply each network-protector circuit with a switchgear-mounted fuse truck, with Class L fuses rated for 200 kA interrupting capacity and key interlocked with each associated protector.
b) Supply each network-protector circuit with a switchgear-mounted main circuit breaker rated for fault current that can be delivered by network transformers, less one. Use drawout type to provide a means of isolating load side of each protector from network bus.

P. Secondary Distribution Low-Voltage Instrument Section :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Standard Features:

a. Instrument Transformers: Comply with IEEE C57.13.

1) Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 Accuracy Class of 0.3 with burdens of W, X, and Y.
2) Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.

b. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1) Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2) Switch-selectable digital display with the following features:

a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i) Accumulated energy, in **MWh (MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3) Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring."
4) Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

c. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1) Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2) Voltmeter Selector Switch: Rotary type with "off" position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3) Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4) Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in "off" position.
5) Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6) Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7) Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a) Operation: Counts and records a succession of pulses entering two channels.
b) Housing: Drawout, back-connected case arranged for semiflush mounting.

d. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
e. Surge Suppression:

1) Factory installed as an integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:

a) Integral disconnect switch.
b) Internal thermal protection that disconnects SPD before damaging internal suppressor components.
c) Indicator light display for protection status.
d) Form-C contacts rated at 5 A 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.**]
e) Surge counter.

2) Field-mounted surge suppressors complying with Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits." Include the following features and accessories:

a) Integral disconnect switch.
b) Internal thermal protection that disconnects SPD before damaging internal suppressor components.
c) Indicator light display for protection status.
d) Form-C contacts rated at 5 A 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.**]
e) Surge counter.

f. Control Power Supply:

1) From medium-voltage instruments section.
2) Control power transformer supplying 120 V control circuits through secondary disconnect devices.

g. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1) Flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2) Conductors sized in accordance with NFPA 70 for duty required.

2.3 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing secondary unit substation, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Spare Fuses: [**Six**]<**Insert number**> of each type and rating of fuse and fusible device used, except for medium-voltage fuses[**and fuses associated with network protector**]. Include spares for the following:

a. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading.

1) Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will

operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.

2) Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.
3) Indicator integral with each fuse to show when it has blown.
4) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

2. Spare Indicating Lights: Six of each type installed.
3. [**One**]<**Insert number**> set(s) of spare mounting gaskets for bushings, handholes, and gasket between relief cover and flange of pressure-relief device.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to secondary unit substation, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Control-power battery hoist.
2. Switchgear Circuit-Breaker Test Cabinet:

a. Separately mounted.
b. Containing push buttons for circuit-breaker closing and tripping, control relay, fuses, and secondary coupler with cable approximately **108 inch (2740 mm)** long.
c. Include secondary devices for operating circuit breaker if removed from switchgear and moved near test cabinet.
d. Include provision for storage of test and maintenance accessories in cabinet.

3. Switchgear Maintenance Tools: Furnish tools and miscellaneous items required for switchgear test, inspection, maintenance, and operation.

a. Fuse-handling tool.
b. Relay and meter test plugs.
c. Extension rails, lifting device, transport or dockable dolly or mobile lift, and all other items necessary to remove circuit breaker from housing and transport to remote location.
d. Racking handle to move circuit breaker manually between "connected" and "disconnected" positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.

4. Transformer Accessories Set: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers must have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap.[**Include the following additional accessories:**]

a. Liquid-level gauge.
b. Pressure-vacuum gauge.
c. Liquid temperature indicator.
d. Drain and filter valves.
e. Pressure-relief device.

5. Low-Voltage Instruments Maintenance Tools: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

a. Racking handle to manually move circuit breaker between "connected" and "disconnected" positions.
b. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without

removal from switchgear.

c. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

d. Circuit-Breaker Removal Apparatus:

1) Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.

2) Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

e. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

f. Storage for Manual: Include a rack or holder, near operating instructions, for a copy of maintenance manual.

C. Consumable Items:

1. After completion of field quality control, startup, commissioning, adjusting, and closeout activities, replace air filters and refill fuel tanks and fluid reservoirs.

2. Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

a. Touchup Paint: [**Three**]<**Insert number**> half-pint containers of paint matching enclosure's exterior finish.

b. Primary Switch Contact Lubricant: [**One**]<**Insert number**> container(s).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at secondary unit substation location.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SECONDARY UNIT SUBSTATIONS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Communications Work: BICSI N1.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
12. Installation of Switchboards: NECA NEIS 400.
13. Installation of Liquid-Filled Transformers: NECA NEIS 410.
14. Installation of Medium-Voltage Metal-Clad Switchgear: NECA NEIS 430.
15. Installation and Maintenance of AC Outdoor High-Voltage Circuit Breakers: NEMA SG 11.
16. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's instructions and NFPA 70.

D. Interfaces with Other Work:

1. Identification: Provide signs and labels for secondary unit substation and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
    d. Install number of signs required to be readable from each accessible side, but space signs a maximum of **30 ft (9 m)** apart.
    e. Operating Instructions: Place printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures with maintenance materials.

2. Install secondary unit substations on concrete equipment base(s).
3. Provide vibration isolation and seismic control devices.
4. Grounding and Bonding:

    a. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
    b. At Exterior Locations:

        1) For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as indicated. Keep lead lengths as short as practicable with no kinks or sharp bends.
        2) Fence and equipment connections must not be smaller than 4 AWG. Ground fence

at each gate post and corner post and at intervals not exceeding **10 ft (3 m)**. Bond each gate section to fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.

3) Make joints in grounding conductors and loops by exothermic weld or compression connector.

5. Connect feeder, branch-circuit, and instrumentation wiring.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. General Field Testing Requirements:

1. Comply with provisions of NFPA 70B, "Testing and Test Methods" Chapter.
2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
3. After installing secondary unit substation but before primary is energized, verify that grounding system at substation is tested at specified value or less.
4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
5. Visual and Mechanical Inspection:

a. Verify equipment nameplate data complies with Contract Documents.
b. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

6. Remove and replace malfunctioning units and retest.
7. Prepare test and inspection reports. Record as-left set points of all adjustable devices.

D. Switchgear Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and required area clearances.
c. Verify unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
d. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study as well as to address of circuit breaker that is used to identify it in microprocessor-communication software.
e. Verify that current and voltage-transformer ratios correspond to Drawings.
f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
2) Make key exchange with devices operated in off-normal positions.

g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
h. Inspect insulators for evidence of physical damage or contaminated surfaces.
i. Verify correct barrier and shutter installation and operation.
j. Exercise all active components.
k. Inspect mechanical indicating devices for correct operation.
l. Verify that filters are in place and vents are clear.
m. Inspect control power transformers as follows:

1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
2) Verify that primary- and secondary-fuse or circuit-breaker ratings match Drawings and comply with manufacturer's published instructions.
3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

a. Perform DC voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If temperature of bus is other than plus or minus 20 deg C, adjust resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.1.
2) Do not proceed to dielectric-withstand-voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform a dielectric-withstand-voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, conduct it in accordance with NETA ATS, Table 100.2. Apply test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, test specimen is considered to have passed test.

c. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate applied voltage, follow manufacturer's published instructions.

1) Minimum insulation-resistance values of control wiring must not be less than 2 MΩ.

d. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at all devices.
2) Verify secondary voltages by energizing primary winding with system voltage.

e. Perform current-injection tests on entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in secondary circuit. Verify correct magnitude of current at each device in circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in secondary circuit. Verify correct magnitude of current at each device in circuit.

f. Verify operation of space heaters.
g. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

E. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify arresters are clean.
d. Verify that ground lead on each device is individually attached to a ground bus or ground electrode.
e. Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

2. Electrical Tests:

a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in table.
b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

F. Medium-Voltage Vacuum Circuit Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and required clearances.
c. Verify that maintenance devices such as special tools and gauges specified by manufacturer are available for servicing and operating breaker.
d. Verify unit is clean.
e. Perform mechanical operation tests on operating mechanism in accordance with manufacturer's published data.
f. Measure critical distances on operating mechanism in accordance with manufacturer's published instructions. Critical distances of operating mechanism must be in accordance with manufacturer's published data.

g. Verify cell fit and element alignment.
h. Verify racking mechanism operation.
i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
j. Perform time-travel analysis. Travel and velocity values must be in accordance with manufacturer's published data.
k. Record as-found and as-left operation counter reading. Operation counter must advance one digit per close-open cycle.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's published instructions. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.
b. Perform a contact/pole-resistance test. Compare bolted-connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of lowest value. Microhm or DC millivolt drop values must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of trip and close coils must comply with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
d. Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate in accordance with manufacturer' published data.
e. Trip circuit breaker by operation of each protective device. Reset all trip logs and indicators.
f. Perform power-factor or dissipation-factor tests on each pole with breaker open and each phase with breaker closed. Power-factor or dissipation-factor values must meet manufacturer's published data.
g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with contacts in "open" position in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by end of total time of voltage application during vacuum bottle integrity test, test specimen is considered to have passed test.
h. Perform a dielectric-withstand-voltage test in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, test specimen is considered to have passed test.
i. Verify operation of heaters.

G. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Verify correct connection of transformers with system requirements.
c. Verify that adequate clearances exist between primary and secondary circuit wiring.

d. Verify unit is clean.
e. Verify that required grounding and shorting connections provide contact.
f. Verify correct operation of transformer withdrawal mechanism and grounding operation.
g. Verify correct primary- and secondary-fuse sizes for voltage transformers.
h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate applied voltage, comply with manufacturer's published instructions. Insulation-resistance values of instrument transformers must not be less than values shown in NETA ATS, Table 100.5.
b. Perform a polarity test of each current transformer in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
c. Perform a ratio-verification test using voltage or current method in accordance with IEEE C57.13.1. Ratio errors must comply with IEEE C57.13.
d. Perform an excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match curve supplied by manufacturer or must comply with IEEE C57.13.1.
e. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. The measured burdens must match instrument transformer Accuracy Class rating.
f. Perform insulation-resistance tests on primary winding with secondary grounded. Test voltages must comply with NETA ATS, Table 100.5. The insulation-resistance value must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
g. Perform dielectric-withstand-voltage tests on primary winding with secondary grounded. Test voltages must comply with NETA ATS, Table 100.9. If no evidence of distress or insulation failure is observed by end of total time of voltage application, primary winding is considered to have passed test.
h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with test equipment manufacturer's published data.
i. Verify that current-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

3. Electrical Tests of Voltage and Potential Transformers:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply test voltage for one minute in accordance with NETA ATS, Table 100.5. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's published instructions. Insulation-resistance values of instrument transformers must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages must be applied for one minute in accordance with NETA ATS, Table 100.5. Insulation-resistance values of transformers must not be less than values shown in NETA ATS, Table 100.5.
c. Perform a polarity test on each transformer to verify polarity marks or H(1)-X(1) relationship. Polarity results must agree with transformer markings.
d. Perform a turns-ratio test on all tap positions. Ratio errors must not exceed tolerances specified in IEEE C57.13.

e. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared to instrument transformer ratings. The measured burdens must match instrument transformer Accuracy Class rating.
f. Perform a dielectric-withstand-voltage test on primary windings with secondary windings connected to ground. The dielectric voltage must comply with NETA ATS, Table 100.9. The test voltage must be applied for one minute. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, primary windings are considered to have passed test.
g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with test equipment manufacturer's published data.
h. Verify that voltage-transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.

H. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean front panel and remove foreign material from case.
e. Check tightness of connections.
f. Verify that frame is grounded in accordance with manufacturer's published instructions.
g. Set relay in accordance with results in Section 260573 "Power System Studies."
h. Download settings from relay. Print a copy of settings for report and compare settings to those specified in coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of relay meter functions.
c. Functional Operation: Check functional operation of each element used in protection scheme as follows:

1) Timing Relay (IEEE C37.2 Device No. 2):

a) Determine time delay.
b) Verify operation of instantaneous contacts.

2) Volts Per Hertz Relay (IEEE C37.2 Device No. 24):

a) Determine pickup frequency at rated voltage.
b) Determine pickup frequency at a second voltage level.
c) Determine time delay.

3) Sync Check Relay (IEEE C37.2 Device No. 25):

a) Determine closing zone at rated voltage.
b) Determine maximum voltage differential that permits closing at zero degrees.
c) Determine live line, live bus, dead line, and dead bus set points.
d) Determine time delay.

e) Verify dead bus/live line, dead line/live bus, and dead bus/dead line control functions.

4) Undervoltage Relay (IEEE C37.2 Device No. 27):

a) Determine dropout voltage.
b) Determine time delay.
c) Determine time delay at a second point on timing curve for inverse time relays.

5) Directional Power Relay (IEEE C37.2 Device No. 32):

a) Determine minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Determine time delay.
e) Verify time delay at a second point on timing curve for inverse time relays.
f) Plot operating characteristic.

6) Loss of Excitation/Field Relay (IEEE C37.2 Device No. 40):

a) Determine maximum reach.
b) Determine maximum torque angle.
c) Determine offset.
d) Plot impedance circle.

7) Phase Balance Current Relay (IEEE C37.2 Device No. 46):

a) Determine pickup of each unit.
b) Determine percent slope.
c) Determine time delay.

8) Negative Sequence Current Relay (IEEE C37.2 Device No. 46):

a) Determine negative sequence alarm level.
b) Determine negative sequence minimum trip level.
c) Determine maximum time delay.
d) Verify two points on I-two-squared-t curve.

9) Phase Sequence or Phase Balance Voltage Relay (IEEE C37.2 Device No. 47):

a) Determine positive sequence voltage to close N.O. contact.
b) Determine positive sequence voltage to open N.C. contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close N.O. contact with sudden application of 120 percent of pickup.
e) Determine time delay to close N.C. contact upon removal of voltage when previously set to rated system voltage.

10) Thermal Replica Relay (IEEE C37.2 Device No. 49):

a) Determine time delay at 300 percent of setting.
b) Determine a second point on operating curve.
c) Determine pickup.

11) RTD Biased Thermal Overload Relay (IEEE C37.2 Device No. 49RTD):

a) Determine RTD resistance trip setting.
b) Determine RTD resistance reset setting.

12) Instantaneous Overcurrent Relay (IEEE C37.2 Device No. 50):

a) Determine pickup.
b) Determine dropout.
c) Determine time delay.

13) Time Overcurrent Relay (IEEE C37.2 Device No. 51):

a) Determine minimum pickup.
b) Determine time delay at two points on time current curve.

14) Power-Factor Relay (IEEE C37.2 Device No. 55):

a) Determine tripping angle.
b) Determine time delay.

15) Overvoltage Relay (IEEE C37.2 Device No. 59):

a) Determine overvoltage pickup.
b) Determine time delay to close contact with sudden application of 120 percent of pickup.

16) Voltage Balance Relay (IEEE C37.2 Device No. 60):

a) Determine voltage difference to close contacts with one source at rated voltage.
b) Plot operating curve for relay.

17) Sudden Pressure Relay (IEEE C37.2 Device No. 63):

a) Determine rate-of-rise or pickup level of suddenly applied pressure in accordance with manufacturer's published data.
b) Verify operation of auxiliary relay (IEEE C37.2 Device No. 63X) seal-in circuit.
c) Verify trip circuit to remote operating device.

18) Ground Detector Relay (IEEE C37.2 Device No. 64):

a) Determine maximum impedance to ground causing relay pickup.

19) Directional Overcurrent Relay (IEEE C37.2 Device No. 67):

a) Determine directional unit minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Plot operating characteristics.
e) Determine overcurrent unit pickup.
f) Determine overcurrent unit time delay at two points on time current curve.

20) Reclosing Relay (IEEE C37.2 Device No. 79):

a) Determine time delay for each programmed reclosing interval.
b) Verify lockout for unsuccessful reclosing.
c) Determine reset time.
d) Determine close pulse duration.
e) Verify instantaneous overcurrent lockout.

21) Frequency Relay (IEEE C37.2 Device No. 81):

a) Verify frequency set points.
b) Determine time delay.
c) Determine undervoltage cutoff.

22) Pilot Wire Monitor (IEEE C37.2 Device No. 85):

a) Determine overcurrent pickup.
b) Determine undercurrent pickup.
c) Determine pilot wire ground pickup level.

23) Differential Protective Relay (IEEE C37.2 Device No. 87):

a) Determine operating unit pickup.
b) Determine operation of each restraint unit.
c) Determine slope.
d) Determine harmonic restraint.
e) Determine instantaneous pickup.
f) Plot operating characteristics for each restraint.

d. Control Verification:

1) Functional Tests:

a) Check operation of all active digital inputs.
b) Check output contacts or SCRs, preferably by operating controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) For pilot schemes, perform a loop-back test to check receive and transmit communication circuits.
e) For pilot schemes, perform satellite synchronized end-to-end tests.
f) For pilot schemes with direct transfer trip (DTT), perform transmit and received DTT at each terminal.
g) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

I. DC System VRLA Batteries Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify equipment nameplate data complies with Contract Documents.
e. Inspect physical and mechanical condition.

f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify units are clean.
h. Inspect spill containment installation.
i. Verify application of an oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust voltage in accordance with battery manufacturer's published instructions.
b. Verify charger functions and that alarms comply with system manufacturer's published instructions.
c. Measure negative post temperature. Negative post temperature must comply with manufacturer's published data or IEEE 1188.
d. Measure charger float and equalizing voltage levels. Charger float and equalizing voltage levels must be in accordance with battery manufacturer's published data.
e. Measure each monoblock/cell voltage and total battery voltage with charger energized and in float mode of operation. Monoblock/cell voltages must be in accordance with manufacturer's published data.
f. Measure intercell connection resistances.
g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical monoblocks/cells in a fully charged state.
h. Perform a load test in accordance with manufacturer's published data or IEEE 1188. Replace units that fail to pass test.
i. Measure battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground must be equal in magnitude to voltage measured from negative-to-ground.

J. DC System Vented Ni-Cd Batteries Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify equipment nameplate data complies with Contract Documents.
e. Inspect physical and mechanical condition.
f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify electrolyte level. Measure pilot-cell electrolyte temperature, and correct in accordance with manufacturer's maintenance procedures to bring temperature and electrolyte level to within normal limits.
h. Verify units are clean.
i. Inspect spill containment installation.
j. Verify application of an oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust voltage in accordance with battery manufacturer's published instructions.
b. Verify charger functions and that alarms comply with system manufacturer's published instructions.
c. Measure each cell voltage and total battery voltage with charger energized and in float

mode of operation. Cell voltages must be within 0.05 volt of each other or in accordance with manufacturer's published data.

d. Measure intercell connection resistances.
e. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state.
f. Perform a load test in accordance with manufacturer's published data or IEEE 1106. Replace units that fail to pass test.
g. Measure battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground must be equal in magnitude to voltage measured from negative-to-ground.

K. DC System Charger Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect for physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify unit is clean.
d. Inspect filter and tank capacitors.
e. Verify operation of cooling fans and presence of filters.

2. Electrical Tests:

a. Verify float voltage, equalizing voltage, and overvoltage shutdown settings. Float and equalizing voltage settings must be in accordance with battery manufacturer's published data.
b. Verify current limit. Current limit must be set in accordance with manufacturer's published instructions.
c. Verify operation of alarms. Results of alarm operation must be in accordance with manufacturer's published data and system design.
d. Measure and record input and output voltage and current. Input and output voltage must be in accordance with manufacturer's published data.
e. Measure and record AC ripple current and voltage imposed on battery. AC ripple current and voltage imposed on battery must be in accordance with manufacturer's published data.
f. Perform full-load testing of charger. Charger must be capable of manufacturer's specified full load.

L. Liquid-Filled Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect impact recorder prior to unloading.
c. Test dew point of tank gases if applicable.
d. Inspect anchorage, alignment, and grounding.
e. Verify presence of PCB content labeling.
f. Verify removal of any shipping bracing after placement.
g. Verify bushings are clean.
h. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate in accordance with manufacturer's published instructions.
i. Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection.
j. Verify that liquid level in tanks and bushings is within manufacturer's published tolerances.
k. Perform specific inspections and mechanical tests recommended by manufacturer's

published instructions.
l. Verify presence of transformer surge arresters and that their ratings are as specified.
m. Verify that as-left tap connections are as specified.
n. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
c. Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
e. Perform turns-ratio tests at tap positions. Turns-ratio test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
f. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows a different pattern.
g. Measure resistance of each winding at each tap connection, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
h. Perform an applied-voltage test on primary and secondary windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9.
i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
j. Remove a sample of insulating liquid in accordance with ASTM D923. Insulating liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

1) Dielectric Breakdown Voltage: ASTM D877/D877M or ASTM D1816.
2) Acid Neutralization Number: ASTM D974.
3) Specific Gravity: ASTM D1298.
4) Interfacial Tension: ASTM D971.
5) Color: ASTM D1500.
6) Visual Condition: ASTM D1524.
7) Water in Insulating Liquids: ASTM D1533.
8) Power Factor or Dissipation Factor: ASTM D924.

k. Remove a sample of insulating liquid in accordance with ASTM D923 and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

M. Small Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer's published instructions.
f. Verify that as-left tap connections are as specified.

g. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform turns-ratio tests at all tap positions. The test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
c. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

N. Large Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate in accordance with manufacturer's published instructions.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by manufacturer's published instructions.
h. Verify that as-left tap connections are as specified.
i. Verify presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:

1) 2.0 percent for power transformers.
2) 5.0 percent for distribution transformers.

c. Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 MΩ at 500 V(dc).
d. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent must be investigated.
e. Perform turns-ratio tests at all tap positions. The test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
f. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows a different pattern.
g. Measure resistance of each winding at each tap connection.
h. Perform an applied-voltage test on all primary and secondary windings-to-ground. See

IEEE C57.12.91, Sections 10.2 and 10.9. The AC dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for one-minute duration. The DC dielectric-withstand-voltage test result must not exceed 100 percent of AC RMS test voltage specified in IEEE C57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric-withstand-voltage test, test specimen is considered to have passed test.

i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

O. Secondary Distribution Section Network Protector Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify unit is clean.
d. Verify arc chutes are intact.
e. Inspect moving and stationary contacts for condition and alignment.
f. Verify that maintenance devices are available for servicing and operating network protector.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of network protector are correct.
h. Perform mechanical operator and contact alignment tests on both network protector and its operating mechanism. Operations counter must advance one digit per close-open cycle.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify compliance with manufacturer's published instructions for lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Record as-found and as-left operation counter readings.
m. Perform a leak test on submersible enclosure in accordance with manufacturer's published data.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with network protector closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or Table 100.1.
2) Do not conduct insulation-resistance tests of control wiring until insulation-resistance levels of power circuits are raised above minimum values.

b. Perform a contact/pole-resistance test. Microhm or DC millivolt drop values must not exceed high levels of normal range as indicated in manufacturer's published data. In absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar protectors by more than 50 percent of lowest value.

3. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate applied voltage, follow manufacturer's published instructions.

a. Minimum insulation-resistance values of control wiring must not be less than 2 MΩ.
b. Verify current-transformer ratios in accordance with IEEE C57.13.
c. Measure resistance of each network protector power fuse. Investigate and correct fuse-resistance values that deviate from each other by more than 15 percent.
d. Measure minimum pickup voltage of motor-control relay. Minimum pickup voltage of motor-control relay must be in accordance with manufacturer's published data, but not more than 75 percent of rated control circuit voltage.
e. Verify that motor can charge closing mechanism at minimum voltage specified by manufacturer. Minimum operating voltage of motor on closing mechanism must not exceed 75 percent of rated control circuit voltage.
f. Measure minimum pickup voltage of trip actuator. Trip actuator minimum pickup voltage must not exceed 7.5 percent of rated control circuit voltage. Verify that actuator resets correctly.
g. Calibrate network protector relays in accordance with "Medium-Voltage Instruments Section" Paragraph, "Overcurrent and Ground-Fault Protective Relays" Subparagraph, specifying microprocessor-based protective relays.
h. Perform the following operational tests:

1) Verify correct operation of all mechanical and electrical interlocks.
2) Verify trip-free operation.
3) Verify correct operation of auto-open-close control handle.
4) Verify protector will close with voltage on transformer side only.
5) Verify protector will open when source feeder breaker is opened.

i. Verify phase rotation, phasing, and synchronized operation.

P. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that all maintenance devices are available for servicing and operating breaker.
d. Verify unit is clean.
e. Verify that arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
h. Perform mechanical operator and contact alignment tests on both breaker and its operating mechanism in accordance with manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings in accordance with coordination study provided by end user.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply

with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's published instructions must be investigated.

b. Measure contact resistance across each power contact of circuit breaker. Microhm or DC millivolt drop values must not exceed high levels of normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

c. Determine long-time pickup and delay by primary current injection. Long-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times must not exceed value shown in NETA ATS, Table 100.7.

d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.

e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic must not exceed manufacturer's published time-current tolerance band.

f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In absence of manufacturer's published data, comply with NETA ATS, Table 100.8.

g. Test functions of trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.

h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must conform to manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.20.

i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in accordance with manufacturer's published data.

k. Verify operation of charging mechanism. The charging mechanism must operate in accordance with manufacturer's published data.

Q. Metering Device Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.

c. Verify unit is clean.

d. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

a. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.

b. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.

c. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.

d. Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results must confirm integrity of secondary circuits of current and voltage transformers.

R. Nonconforming Work:

1. Equipment will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

S. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

T. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Complete installation and startup checks required by electric utility provider.
3. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

   a. Adjust transformer taps.
   b. Rebalance loads.
   c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Report:

a. Prepare a written report covering monitoring performed and corrective action taken.
b. For each relay and adjustable circuit breaker, tag device with adjusting technician's initials and date of adjustment. Record settings and file with test records specified in "Field Quality Control" Article.

B. Infrared Inspection and Adjusting: Perform survey during periods of maximum possible loading. Remove all necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of electrical power connections of unit substation.
2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
3. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of **1.8 deg F (1 deg C)** at **104 deg F (30 deg C)**.
4. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists the following results:

a. Description of equipment to be tested.
b. Discrepancies.
c. Temperature difference between area of concern and reference area.
d. Probable cause of temperature difference.
e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of deficient area.

5. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.6 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.7 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to operate normal and emergency electrical systems, including justifications for, and limitations of, protective device settings recommended in coordination study report.
b. How to adjust, operate, and maintain secondary unit substation equipment.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

3.8 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three month**][**six month**][**nine year**][**one year**]<**Insert duration**> period for full

maintenance by [**skilled employees of secondary unit substation Installer**][**manufacturer's authorized service representative**]. Include periodic preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper secondary unit substation equipment operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

B. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes secondary unit substation equipment software and firmware support for [**two years**]<**Insert duration**>.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two years**]<**Insert duration**> from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

    a. Upgrade Notice: Not less than [**30 days**]<**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 26 11 16 11

Task	Specification	Specification Description
26 11 16 11	26 11 16 00	Secondary Unit Substations with Switchboard Secondary
26 11 16 11	26 11 16 00a	Secondary Unit Substations with Motor Control Center Secondary

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SECTION 26 12 13 00 - LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Liquid-filled, medium-voltage substation transformers, with primary and secondary bushings within or without air-terminal enclosures.
2. Control network.
3. Warning labels and signs.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. <**Insert products installed, but not furnished**>.

D. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For liquid-filled, medium-voltage transformers. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated capacities, operating characteristics, and furnished specialties and

accessories.

B. Shop Drawings:

1. For liquid-filled, medium-voltage transformers.

a. Include plans and elevations showing major components and features.

1) Include plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits.

b. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
c. Include single-line diagram.
d. Include list of materials.
e. Include nameplate legends.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For transformers, signed by product manufacturer.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.4 LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Eaton**]
2. [**GE Power; General Electric Company**]
3. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

2.5 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.00.

2.6 PERFORMANCE REQUIREMENTS

A. Windings Material: [**Aluminum**][**Copper**].

B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

C. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.

D. Efficiency: Comply with 10 CFR 431, Subpart K.

E. Insulation:

1. Transformer kVA Rating[**, when Indicated at 65 deg C Rise,**] Must Be as Follows: Average winding temperature rise above ambient temperature must not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested in accordance with IEEE C57.12.90, using combination of connections and taps that give highest average winding temperature rise.
2. Transformer kVA Rating[**, when Indicated at 55/65 deg C Rise,**] Must Be as Follows: Average winding temperature rise above ambient temperature must not exceed 55 deg C, based on average ambient temperature of 30 deg C over 24 hours with maximum ambient temperature of 40 deg C. Insulation system must be rated to continuously allow additional 12-percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life. Rating must conform to requirements of IEEE C57.12.90.

F. Bushings must comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.

G. Tap Changer: External, for de-energized operation.

H. Tank: Sealed, with welded-on cover.[**Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.**]

I. Mounting: Integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

J. Insulating Liquids:

1. Mineral Oil: ASTM D3487, Type II, and tested for compliance with ASTM D117.
2. Less-Flammable Liquids:

a. Edible-Seed-Oil-Based Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic, having passed Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and must be certified by U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.
b. Biodegradable and Nontoxic Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92.
c. Silicone-Based Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must have low toxicity and be nonhazardous.

K. Sound level must comply with NEMA TR 1 requirements.

L. Capacities and Characteristics:

1. Location: [**Indoors**][**Outdoors**].
2. Additional Standards: Comply with [**IEEE C57.12.10**][**IEEE C57.12.36**].

a. Comply with [**IEEE C57.12.10**][**IEEE C57.12.36**].
b. Comply with UL 1062 listing requirements.
c. Comply with FM Global Class No. 3990.
d. Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

3. Connections:

a. Primary: [**Air-filled terminal cabinet for cable connection**][**Throat for busway connection**][**Terminals for close connection to primary switch**][**Open wire**].
b. Secondary: [**Air-filled terminal cabinet for cable connection**][**Throat for busway connection**][**Open wire**].

4. Transformer Ratings. Comply with IEEE C57.12.00 for cooling class.

a. Self-Cooled Rating, Class <**Insert letters**>: <**Insert number**> kVA.
b. Future Forced-Air-Cooled Rating, Class <**Insert letters**>:

1) Self-Cooled: <**Insert number**> kVA.
2) Forced-Air Cooled: <**Insert number**> kVA.
3) Make provision for future addition of forced-air-cooling equipment. Transformer bushings, leads, and related components must be sized for future equipment. Provide fan mounts, conduit supports, and terminal boxes.

c. Forced-Air-Cooled Rating, Class <**Insert letters**>:

1) Self-Cooled: <**Insert number**> kVA.
2) Forced-Air Cooled: <**Insert number**> kVA.
3) Equip with forced-air-cooling equipment, including fans, conduit, wiring, motor controllers, and top liquid thermometer for fan control.

d. Impedance: Not less than [**5.75**]<**Insert number**> percent.
e. Temperature Rise: [**65 deg C**][**55/65 deg C**].
f. Coils Connection:

1) Line-Side Winding: [**Delta**]<**Insert connection**>.
2) Load-Side Winding: [**Wye**]<**Insert connection**>.

g. Voltage and BIL Ratings:

1) Nominal primary phase-to-phase voltage and BIL: [**4160 V, 60 kV**][**13 800 V, 95 kV**][**34 500 V, 125 kV**]<**Insert requirements**>.
2) Nominal secondary voltage and BIL: [**208Y/120 V, 45 kV**][**480Y/277 V, 45 kV**]<**Insert requirements**>.

h. K-Factor: <**Insert number**>, complying with UL 1561.

5. Finish:

a. Outdoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard color, corrosion resistance complying with IEEE C57.12.28.
b. Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over rust-inhibiting primer on treated metal surface.
c. Special Corrosion-Resistant Enclosure Finish: Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to salt-spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer

coat to metal surface in excess of 1/16 inch (2 mm) from test mark. Scribed test mark and test evaluation must be in accordance with ASTM D1654 with rating of not less than 7, in accordance with Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel, or mill-galvanized sheet steel must be coated with manufacturer's standard zinc-rich paint.

6. Taps: Two 2-1/2 percent, full-capacity taps above, and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.
7. Transformer Accessories:

   a. Drain and filter connection.
   b. Filling and top filter press connections.
   c. Pressure-vacuum gauge.
   d. Dial-type analog thermometer with alarm contacts.
   e. Magnetic liquid level indicator with high and low alarm contacts.
   f. Pressure-relief device set to operate at 10 psig, plus or minus 2 psig, and then automatically reseal when pressure drops to 6 psig minimum. Device flow must be as recommended by manufacturer. With alarm contacts and manual bleeder.
   g. At least four stainless steel ground connection pads.
   h. Provisions for jacking, lifting, and towing.
   i. Machine-engraved nameplate made of anodized aluminum or stainless steel.
   j. Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide [**with**][**without**] seal-in delay.

2.7 CONTROL NETWORK

A. Controllers: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via RS-485 serial networks and Ethernet 10Base-T networks as native device.

2.8 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

1. Warning signs must be made of baked enamel.
2. Equipment Identification Labels: [**Engraved, laminated-acrylic or -melamine label**][**Stenciled legend 4 inch (100 mm) high**].

2.9 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: [**Owner will engage**][**Engage**] qualified testing agency to evaluate liquid-filled, medium-voltage transformer.

C. Testing: Test and inspect liquid-filled, medium-voltage transformer in accordance with IEEE C57.12.90.

D. Factory Tests and Inspections: Perform the following tests and inspections on liquid-filled, medium-voltage transformer, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance on

control units.

1. Resistance.
2. Turns ratio, polarity, and phase relation.
3. Transformer no-load losses and excitation current at 100 percent of ratings.
4. Transformer impedance voltage and load loss.
5. Operation of devices.
6. Control (auxiliary) and consumption losses.
7. Lightning impulse.
8. Low frequency.
9. Leak.
10. Transformer no-load losses and excitation current at 110 percent of ratings.
11. Insulation power factor.
12. Applied potential.
13. Induced potential.
14. Resistance measurements of windings on rated voltage connection and at tap extreme connections.
15. Ratios on rated voltage connection and at tap extreme connections.
16. Polarity and phase relation on rated voltage connection.
17. No-load loss at rated voltage on rated voltage connection.
18. Exciting current at rated voltage on rated voltage connection.
19. Impedance.

E. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine liquid-filled, medium-voltage transformers upon delivery.

1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on line- or load-side bushing parts, and at transformer base.
5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
7. Verify presence of polychlorinated biphenyl content labeling.
8. Unload transformers carefully, observing packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign

material, and water or moisture.

B. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.
8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Verify that effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine walls, floors, roofs, and concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.
2. Remove sample of insulating liquid in accordance with ASTM D923. Insulating-liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

    a. Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.

b. Acid Neutralization Number: ASTM D974.
c. Specific Gravity: ASTM D1298.
d. Interfacial Tension: ASTM D971.
e. Color: ASTM D1500.
f. Visual Condition: ASTM D1524.
g. Water in Insulating Liquids: ASTM D1533.
h. Power Factor or Dissipation Factor: ASTM D924.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5Ω at transformer location.

I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."

B. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.

C. Comply with requirements for vibration isolation and seismic control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and [**Section 260548 "Vibration and Seismic Controls for Electrical Systems."**][**Section 260548.16 "Seismic Controls for Electrical Systems."**]

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
2. At Exterior Locations:

    a. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep lead lengths as short as practicable, with no kinks or sharp bends.
    b. Fence and equipment connections must not be smaller than 4 AWG. Ground fence at gate post and corner post and at intervals not exceeding **10 ft (3 m)**. Bond gate section to fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
    c. Make joints in grounding conductors and loops by exothermic weld or compression connector.

3. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.

4. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of substations in accordance with Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
b. Perform visual and mechanical inspection and electrical test. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at substation is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated

torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Medium-Voltage Surge Arrester Field Tests:

   a. Visual and Mechanical Inspection:

      1) Inspect physical and mechanical condition.
      2) Inspect anchorage, alignment, grounding, and clearances.
      3) Verify arresters are clean.
      4) Verify that ground lead on device is individually attached to ground bus or ground electrode.
      5) Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

   b. Electrical Test:

      1) Perform insulation-resistance test on arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.
      2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Liquid-Filled Transformer Field Tests:

   a. Visual and Mechanical Inspection:

      1) Test dew point of tank gases if applicable.
      2) Inspect anchorage, alignment, and grounding.
      3) Verify bushings are clean.
      4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
      5) Verify that cooling fans and pumps operate correctly and have appropriate overcurrent protection.
      6) Verify that liquid level in tanks and bushings is within manufacturer's published tolerances.
      7) Perform specific inspections and mechanical tests recommended by manufacturer.
      8) Verify presence of transformer surge arresters and that their ratings are as specified.
      9) Verify that as-left tap connections are as specified.
      10) Verify presence of surge arresters and that their ratings are as specified.

   b. Electrical Tests:

      1) Perform insulation-resistance tests winding-to-winding and winding-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index must not be less than 1.0.
      2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.3.

3) Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values must not be less than 1 M Ω at 500 V(dc).
4) Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
5) Perform turns-ratio tests at tap positions. Turns-ratio test results must not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
6) Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows different pattern.
7) Measure resistance of winding at tap connection, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
8) Perform applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9.
9) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
10) Remove sample of insulating liquid in accordance with ASTM D923, and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

D. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest.

E. Assemble and submit test and inspection reports. Record as-left set points of adjustable devices.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.6 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.
b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Report:

a. Prepare written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare certified report that identifies testing technician and equipment used, and lists results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 26 12 13 00

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Task	Specification	Specification Description
26 12 13 00	26 22 13 00	Low-Voltage Distribution Transformers

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SECTION 26 12 16 00 - DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dry-type, medium-voltage transformers.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 260513 "Medium-Voltage Cables" specifies installation of medium-voltage cables.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies installation of low-voltage wiring.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
11. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. VPE: Vacuum Pressure Encapsulation.

B. VPI: Vacuum Pressure Impregnation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For dry-type, medium-voltage transformers. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Product Certificates: Include product certificate stating compliance with IEEE C57.16, signed by manufacturer or fabricator.

B. Factory test reports.

C. Shop Drawings: Prepare and submit the following:

1. Include plans and elevations showing major components and features.

a. Include plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits.

2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
3. Include single-line diagram.
4. Include list of materials.
5. Include nameplate legends.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

E. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.
3. Field reports for infrared scanning.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
5. Unload transformers carefully, observing packing label warnings and handling instructions.
6. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.

4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Visually check for rust spots.

C. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and transformer case.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
6. Use jacks only at corners of base plate of transformer case.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.
8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage base structure of case when handling transformer using skids or rollers. Use skids to distribute stresses over case base when using rollers under large transformers.

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Environmental Conditions," "Outdoor Conditions," and "Indoor Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C57 series standards.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 MEDIUM-VOLTAGE TRANSFORMERS

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate transformer.
c. Factory Tests and Inspections: Perform the following tests and inspections on transformer by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.16 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Tests for Transformers 500 kVA and Smaller:

a) Turns ratio, polarity, and phase relation on rated voltage connection.
b) Transformer no-load losses and excitation current at 100 percent of ratings. This test may be based on a statistical sample.
c) Applied voltage and induced voltage.
d) Partial discharge.
e) Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
f) Temperature rise at minimum and maximum ratings.
g) Impulse.
h) Insulation power factor.
i) Insulation resistance.
j) Audible sound level.
k) Short-circuit capability.
l) Operation of devices.
m) Control (auxiliary) and consumption loss data values.

2) Tests for Transformers 501 kVA and Larger:

a) Resistance measurements of windings on rated voltage tap and at tap extremes.
b) Turns ratio, polarity, and phase relation on rated voltage connection.
c) Transformer no-load losses and excitation current at 100 percent of ratings.
d) Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
e) Applied voltage and induced voltage.
f) Partial discharge.
g) Leak test.
h) Temperature rise at minimum and maximum ratings.
i) Impulse.
j) Insulation power factor.
k) Insulation resistance.
l) Audible sound level.
m) Short-circuit capability.
n) Operation of devices.
o) Control (auxiliary) and consumption loss data values.

d. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

e. Factory Test Reports: Compile and submit factory test and inspection reports.

B. Dry-Type, Medium-Voltage Transformers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**GE Power; General Electric Company**]
d. [**Hammond Power Solutions Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**GE Power; General Electric Company**]
d. [**Hammond Power Solutions Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Transformers, Distribution, Dry Type, Over 600 V: UL CCN XPFS; including UL 1562 or IEEE C57.16.

4. Standard Features:

a. Referenced Standards: IEEE C2 and IEEE C57.16.
b. Windings Material: [**Aluminum**][**Copper**].
c. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.
d. Cooling Systems: Comply with IEEE C57.12.01 for cooling class.

1) Self-Cooled Rating, Class <**Insert letters**>: <**Insert number**> kVA.
2) Future Forced-Air-Cooled Rating, Class <**Insert letters**>:

a) Self-Cooled: <**Insert number**> kVA.
b) Forced-Air Cooled: <**Insert number**> kVA.
c) Make provision for future addition of forced-air-cooling equipment. Transformer bushings, leads, and related components must be sized for future equipment. Provide fan mounts, conduit supports, and terminal boxes.

3) Forced-Air-Cooled Rating, Class <**Insert letters**>:

a) Self-Cooled: <**Insert number**> kVA.
b) Forced-Air Cooled: <**Insert number**> kVA.
c) Equip with forced-air-cooling equipment, including fans, conduit, wiring, motor controllers, and thermometer with alarm contacts for fan control.
d) Forced-air cooling must be regulated automatically by sensors placed in load-side winding's air ducts. Forced-air cooling must include three-phase electronic digital temperature monitor, fans, control wiring, control panel with test switch, indicating lights, alarm, and alarm silencing switch.[**Connect to control network.**]

e. Coils Insulation Systems:

1) Primary and secondary coil assemblies must be manufactured using polyester VPI system.
2) Primary and secondary coil assemblies must be manufactured using silicone resin VPE system.
3) Primary coil assembly must be manufactured using <**Insert system description**>. Secondary coil assembly must be manufactured using <**Insert system description**>.

f. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.
g. Efficiency: Comply with 10 CFR 431, Subpart K.
h. Bushings must comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.
i. Tap Changer: External, for de-energized operation.

1) Taps: Two 2-1/2 percent, full-capacity taps above and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.

j. Enclosure:

1) Provide with provisions for lifting and anchoring frame to concrete pad.
2) With integral skid-mounting frame, suitable to allow skidding or rolling of transformer

in any direction.

3) Enclosure Finish:

a) Outdoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard color, corrosion resistant complying with IEEE C57.12.28.
b) Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over rust-inhibiting primer on treated metal surface.
c) Special Corrosion-Resistant Enclosure Finish: Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to salt-spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to metal surface in excess of **1/16 inch (1.6 mm)** from test mark. Scribed test mark and test evaluation must be in accordance with ASTM D1654 with rating of not less than 7 in accordance with Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel, or mill-galvanized sheet steel must be coated with manufacturer's standard zinc-rich paint.

k. Sound level must comply with requirements of NEMA TR 1.
l. Capacities and Characteristics:

1) Enclosure: [**Ventilated**][**Nonventilated**] power transformer, UL 50E [**Type 1**][**Type 2**][**Type 3R**] enclosure.
2) Additional IEEE Standards: Comply with IEEE C57.12.51.
3) Connections:

a) Primary: [**Air-filled terminal cabinet for cable connection**][**Throat for busway connection**][**Terminals for close connection to primary switch**].
b) Secondary: [**Air-filled terminal cabinet for cable connection**][**Throat for busway connection**].

4) Transformer Ratings.

a) Impedance: Not less than [**5.75**]<**Insert number**> percent.
b) Temperature Rise: [**150 deg C**]<**Insert deg C**>.

5) Coils Connection:

a) Line-Side Winding: [**Delta**]<**Insert connection**>.
b) Load-Side Winding: [**Wye**]<**Insert connection**>.

6) Voltage and BIL Ratings:

a) Nominal primary phase-to-phase voltage and BIL: [**4160 V, 30 kV**][**13 800 V, 60 kV**][**34 500 V, 150 kV**]<**Insert requirements**>.
b) Nominal secondary voltage and BIL: [**208Y/120 V, 10 kV**][**480Y/277 V, 10 kV**]<**Insert requirements**>.
c) K-Factor: <**Insert number**>, complying with UL 1562.

7) Taps: Two 2-1/2 percent, full-capacity taps above and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.51 requirements.
8) Transformer Accessories:

a) Dial-type analog thermometer with alarm contacts.
b) At least four stainless steel ground connection pads.

c) Provisions for jacking, lifting, and towing.
d) Machine-engraved nameplate made of anodized aluminum or stainless steel.

9) Heaters: Where outdoor cast-coil transformers are indicated on Drawings, they must include thermostatically controlled space heaters powered from [**external source that remains energized when transformer is de-energized**][**a fused control power transformer connected to primary side of substation transformer**].

m. Control Network: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as native device.

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**2.5**]<**Insert value**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for dry-type, medium-voltage transformers and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders may cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for transformer installation.

D. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.

E. Verify that grounding and bonding connections are in place. Ground (earth) resistance at transformer location may not be greater than [**5 Ω**]<**Insert resistance in ohms**>.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TRANSFORMERS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the

Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Communications Work: BICSI N1.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.
2. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.
3. Grounding and Bonding:

    a. At Interior Locations: For grounding to grounding electrodes, provide bare copper cable not smaller than 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
    b. At Exterior Locations:

        1) For counterpoise, provide tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep lead lengths as short as practicable, with no kinks or sharp bends.
        2) Fence and equipment connections may not be smaller than 4 AWG. Ground fence at gate posts and corner post and at intervals not exceeding **10 ft (3 m)**. Bond gate sections to fence posts using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
        3) Make joints in grounding conductors and loops by exothermic weld or compression connector.

    c. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.
    d. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.

4. Connect low-voltage wiring.

    a. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer's published instructions.
    b. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

5. Terminate medium-voltage cables in incoming section of substations.

D. Interfaces with Other Work:

1. Identification: Provide labels for transformers and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Install transformers on cast-in-place concrete equipment base(s).
3. Provide vibration isolation and seismic control devices.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
b. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at substation is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or

NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Medium-Voltage Surge Arrester Field Tests:

   a. Visual and Mechanical Inspection:

      1) Inspect physical and mechanical condition.
      2) Inspect anchorage, alignment, grounding, and clearances.
      3) Verify arresters are clean.
      4) Verify that ground leads on devices are individually attached to ground bus or ground electrode.
      5) Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

   b. Electrical Test:

      1) Perform insulation-resistance test on arresters, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in that table.
      2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Dry-Type Transformer Field Tests:

   a. Visual and Mechanical Inspection:

      1) Test dew point of tank gases if applicable.
      2) Inspect anchorage, alignment, and grounding.
      3) Verify that resilient mounts are free and that shipping brackets have been removed.
      4) Verify bushings are clean.
      5) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
      6) Verify that cooling fans operate correctly and have appropriate overcurrent protection.
      7) Perform specific inspections and mechanical tests recommended by manufacturer.
      8) Verify that as-left tap connections are as specified.

   b. Electrical Tests:

      1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index may not be less than 1.0.
      2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data.
      3) Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
      4) Perform turns-ratio tests at tap positions. Turns-ratio test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
      5) Perform excitation-current test on each phase. The typical excitation-current test data pattern for three-legged core transformer is two similar current readings and

one lower current reading. Investigate and correct if test shows different pattern.

6) Measure resistance of windings at tap connections, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
7) Perform applied-voltage test on high- and load-side windings-to-ground. Comply with IEEE C57.12.91 provisions for field-deployed dielectric tests. Measurements must be made only when voltage and current have reached stable value. Test must be discontinued immediately in the event current begins to increase without stabilizing. Record test values in Operations and Maintenance Manual.
8) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain transformer equipment.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

3.5 PROTECTION

A. After installation, protect transformer from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformers. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or

deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Adjust transformer taps.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Field Reports for Voltage Monitoring and Adjusting: Prepare written report covering monitoring performed and corrective action taken.

B. Infrared Scanning of Transformers: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies transformer equipment checked, testing technician, equipment used, and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action. List results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 26 12 16 00

Task	Specification	Specification Description
26 12 16 00	26 22 13 00	Low-Voltage Distribution Transformers

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SECTION 26 12 19 00 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pad-mounted, liquid-filled, medium-voltage transformers.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 260513 "Medium-Voltage Cables" specifies installation of medium-voltage cables.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies installation of low-voltage wiring.
7. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
8. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
11. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

B. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."

C. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or nonload break, separable insulated connector (bushing).

D. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

E. Elbow Connector: See "bushing elbow" above.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For {Insert system or product}. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Product Certificates: Include product certificate stating compliance with IEEE C57.12.00, signed by manufacturer or fabricator.

B. Factory test reports.

C. Shop Drawings: Prepare and submit the following:

1. Plans and elevations showing major components and features.

a. Plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.

2. Details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
3. Single-line diagram.
4. List of materials.
5. Nameplate data.

6. Manufacturer's published time-current curves of transformer line-side fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

E. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Manufacturer's field reports for field quality-control support.

C. Field reports for voltage monitoring and adjusting.

D. Field reports for infrared scanning.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on line- or load-side bushing parts, and at transformer base.
5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.

6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
7. Verify presence of polychlorinated biphenyl content labeling.
8. Unload transformers carefully, observing packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure that transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in the presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Verify that effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

C. Handling:

1. Handle transformers carefully, in accordance with manufacturer's recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.
8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Environmental Conditions," "Outdoor Conditions," and "Indoor Conditions" articles of Section 018116

"Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable IEEE C57 series standards.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate transformer.
c. Factory Tests and Inspections: Perform the following tests and inspections on transformer, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.00 before delivering to site. Affix label

with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Resistance.
2) Turns ratio, polarity, and phase relation.
3) Transformer no-load losses and excitation current at 100 percent of ratings.
4) Transformer impedance voltage and load loss.
5) Operation of devices.
6) Lightning impulse.
7) Low frequency.
8) Leak.
9) Perform Optional Tests:

a) Transformer no-load losses and excitation current at 110 percent of ratings.
b) Insulation power factor.
c) Applied potential, except that this test is not required for single-phase transformers or for three-phase Y-Y-connected transformers.
d) Induced potential.
e) Resistance measurements of windings on rated voltage connection and at tap extreme connections.
f) Ratios on rated voltage connection and at tap extreme connections.
g) Polarity and phase relation on rated voltage connection.
h) No-load loss at rated voltage on rated voltage connection.
i) Exciting current at rated voltage on rated voltage connection.
j) Impedance.

d. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

e. Factory Test Reports: Compile and submit factory test and inspection reports.

B. Single-Phase, Pad-Mounted Transformers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**ERMCO-ECI**]
c. [**GE Power; General Electric Company**]
d. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
e. [**Howard Industries, Inc**]
f. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**ERMCO-ECI**]
c. [**GE Power; General Electric Company**]

d. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
e. [**Howard Industries, Inc**]
f. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
g. **<Insert manufacturer's name>**

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Transformers, Distribution, Liquid-Filled Type, Over 600 V: UL CCN XPLH; including IEEE C57.12.00 and IEEE C57.12.28.

4. Standard Features:

   a. [**Oil-filled**][**Less-flammable-liquid-filled**], two-winding, 60 Hz, 65 deg C rise above 30 deg C average ambient, self-cooled transformer.
   b. Reference Standards: IEEE C2 and IEEE C57.12.38.
   c. Windings Material: [**Aluminum**][**Copper**].
   d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into inserts provided in line-side section of transformer. Connected in each phase of incoming circuit and ahead of disconnecting device.
   e. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.
   f. Efficiency: Comply with 10 CFR 431, Subpart K.
   g. Insulation: Transformer kVA rating must be as follows: Average winding temperature rise above 30 deg C ambient temperature must not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested in accordance with IEEE C57.12.90, using combination of connections and taps that give highest average winding temperature rise.
   h. Tap Changer: External handle, for de-energized operation.
   i. Tank: Sealed, with welded-on cover.[**Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.**]
   j. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to public.
   k. Mounting: Integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.
   l. Insulating Liquids:

      1) Mineral Oil: ASTM D3487, Type II, and tested for compliance with ASTM D117.
      2) Less-Flammable Liquids:

         a) Edible-Seed-Oil-Based Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic, having passed Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and must be certified by U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.
         b) Biodegradable and Nontoxic Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92.

   m. Sound level must comply with NEMA TR 1 requirements.

n. Corrosion Protection:

1) Transformer coating system must be factory applied, complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.
2) Fabricate front sill, hood, and tank base of single-compartment transformers from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage, complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], standard color [**green**]<**Insert color**>.
3) Base and Cabinets of Two Compartment Transformers: Fabricate from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage. Coat transformer with manufacturer's standard green color coating complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.

o. Compartment Construction:

1) Single compartment for line- and load-side sections, clamshell style, with provision for padlocking hinged cover and single-point latching.
2) Individual compartments for line- and load-side sections, formed by steel isolating barriers that extend full height and depth of compartments. With hinged, lift-off doors, with stop in open position, three-point latching, and provision for padlocking.
3) Provide [**Type 1**][**Type 2**] terminal arrangement.

p. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.

1) 150 kV BIL current-limiting fuses, conforming to requirements of IEEE C37.42.
2) Interrupting Rating: 50 000 A(rms sym) at system voltage.
3) Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse must sense both high currents and high oil temperatures to provide transformer with thermal protection.
4) Provide bayonet fuse assembly with oil retention valve and external drip shield inside housing to eliminate or minimize oil spills. Valve must close when fuse holder is removed.
5) Provide conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

q. Line-Side Section: Dead-front design.

1) To connect primary cable, use separable insulated connectors. Bushings must be one-piece units, with ampere and BIL ratings same as connectors.
2) Bushing inserts[**and feed-through inserts**]:

a) Conform to requirements of IEEE 386.
b) Rated at 200 A, with voltage class matching connectors. Provide parking stand near bushing wells.[**Parking stands must be with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.**]
c) Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts[**and insulated standoff bushings**].

3) Bushing wells configured for loop-feed application.

4) Access to liquid-immersed fuses.
5) Dead-front surge arrester(s).
6) Tap-changer operator.
7) Ground pad.

r. Load-Side Section:

1) Bushings with spade terminals drilled for terminating number of conductors indicated on the Drawings, and lugs that comply with requirements of Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2) Metering: Coordinated with and complying with requirements of Section 262713 "Electricity Metering." [**Install**][**Make provision for installation by providing mounting space, brackets, and cable and conduit routing as well as**] the following:

a) Sensors.
b) BAS interface.
c) Kilowatt-hour meter.
d) Kilowatt-hour demand meter.

s. Capacities and Characteristics:

1) Power Rating: <**Insert number**> kVA.
2) Voltage Ratings: <**Insert primary voltage**> V - [**240/120**][**480/240**] V.
3) Taps: [**Four 2.5 percent, full-capacity taps below rated primary voltage**]<**Insert description**>.
4) Transformer BIL (kV): [**Comply with IEEE C57.12.38 requirements**]<**Insert number**>.
5) Minimum Tested Impedance (Percent) at 85 deg C: [**1.25**][**2.1**][**3.0**][**3.2**]<**Insert number**>.

t. Transformer Accessories:

1) Drain and filter connection.
2) Filling and top filter press connections.
3) Pressure-vacuum gauge.
4) Dial-type analog thermometer with alarm contacts.
5) Magnetic liquid level indicator with high and low alarm contacts.
6) Automatically resetting pressure-relief device. Device flow must be as recommended by manufacturer.[**With alarm contacts and manual bleeder.**]
7) Stainless steel ground connection pads.
8) Machine-engraved nameplate made of anodized aluminum or stainless steel.
9) Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide [**with**][**without**] seal-in delay.

u. Control Network: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as native device.

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
b. Component Importance Factor (Ip): [**1.0**][**1.5**].

c. Component Amplification Factor (ap): [**1.0**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**2.5**]<**Insert value**>.

C. Three-Phase, Pad-Mounted Transformers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Eaton**]
   b. [**ERMCO-ECI**]
   c. [**GE Power; General Electric Company**]
   d. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   e. [**Howard Industries, Inc**]
   f. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Eaton**]
   b. [**ERMCO-ECI**]
   c. [**GE Power; General Electric Company**]
   d. [**Hitachi Energy USA Inc.; business of Hitachi, Ltd.**]
   e. [**Howard Industries, Inc**]
   f. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
   g. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Transformers, Distribution, Liquid-Filled Type, Over 600 V: UL CCN XPLH; including IEEE C57.12.00 and IEEE C57.12.28.

4. Standard Features:

   a. [**Oil-filled**][**Less-flammable-liquid-filled**], two-winding, 60 Hz, 65 deg C rise above 30 deg C average ambient, self-cooled transformer.
   b. Reference Standards: IEEE C2 and IEEE C57.12.26.
   c. Windings Material: [**Aluminum**][**Copper**].
   d. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into inserts provided in line-side section of transformer. Connected in each phase of incoming circuit and ahead of disconnecting device.
   e. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.
   f. Efficiency: Comply with 10 CFR 431, Subpart K.
   g. Insulation: Transformer kVA rating must be as follows: Average winding temperature rise above 30 deg C ambient temperature must not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested in accordance with IEEE C57.12.90, using

combination of connections and taps that give highest average winding temperature rise.

h. Tap Changer: External handle, for de-energized operation.

i. Tank: Sealed, with welded-on cover.[**Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.**]

j. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to public.

k. Mounting: Integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

l. Insulating Liquids:

1) Mineral Oil: ASTM D3487, Type II, and tested for compliance with ASTM D117.

2) Less-Flammable Liquids:

a) Edible-Seed-Oil-Based Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92. Liquid must be biodegradable and nontoxic, having passed Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and must be certified by U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.

b) Biodegradable and Nontoxic Dielectric: Listed and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested in accordance with ASTM D92.

m. Sound level must comply with NEMA TR 1 requirements.

n. Corrosion Protection:

1) Transformer coating system must be factory applied, complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.

2) Fabricate front sill, hood, and tank base of single-compartment transformers from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage, complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], standard color [**green**]<**Insert color**>.

3) Base and Cabinets of Two Compartment Transformers: Fabricate from stainless steel in accordance with ASTM A167, Type 304 or 304L, not less than No. 13 U.S. gage. Coat transformer with manufacturer's standard green color coating complying with requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.

o. Compartment Construction:

1) Single-Compartment Construction: Clamshell style, with provision for padlocking, hinged cover, and single-point latching.

2) Double-Compartment Construction: Individual compartments for line- and load-side sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with stop in open position and provision for padlocking.

p. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.

1) 150 kV BIL current-limiting fuses, conforming to requirements of IEEE C37.42.

2) Interrupting Rating: 50 000 A(rms sym) at system voltage.
3) Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse must sense both high currents and high oil temperature to provide thermal protection to transformer.[**Connect current-limiting fuses ahead of radial-feed load-break switch.**]
4) Provide bayonet fuse assembly with oil retention valve and external drip shield inside housing to eliminate or minimize oil spills. Valve must close when fuse holder is removed and external drip shield is installed.
5) Provide conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

q. Line-Side Section: Dead-front design.

1) To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 260513 "Medium-Voltage Cables." Bushings must be one-piece units, with ampere and BIL ratings same as connectors.
2) Bushing inserts[**and feed-through inserts**]:

a) Conform to requirements of IEEE 386.
b) Rated at 200 A, with voltage class matching connectors. Provide parking stand near bushing wells.[**Parking stands must be equipped with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.**]
c) Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts[**and insulated standoff bushings**].

3) Bushing wells configured for loop-feed application.
4) Access to liquid-immersed fuses.
5) Dead-front surge arresters.
6) Tap-changer operator.
7) Ground pad.

r. Load-Break Switch:

1) Radial-feed, liquid-immersed type with voltage class and BIL matching that of separable connectors, with continuous current rating and load-break rating of [**200 A**][**300 A**]<**Insert amperage**>, and make-and-latch rating of 12 kA(rms sym).
2) Loop-feed sectionalizing switches, using three two-position, liquid-immersed-type switches for closed transition loop-feed and sectionalizing operation. Voltage class and BIL must match that of separable connectors, with continuous current rating and load-break rating of [**200 A**][**300 A**]<**Insert amperage**>, and make-and-latch rating of 12 kA(rms sym). Switch operation must be as follows:

a) Position I: Line A connected to line B and both lines connected to transformer.
b) Position II: Transformer connected to line A only.
c) Position III: Transformer connected to line B only.
d) Position IV: Transformer disconnected and line A not connected to line B.
e) Position V: Transformer disconnected and line A connected to line B.

s. Load-Side Section:

1) Bushings with spade terminals drilled for terminating number of conductors indicated on the Drawings, and lugs that comply with requirements of Section 260519 "Low-

Voltage Electrical Power Conductors and Cables."

2) Metering: Coordinated with and complying with requirements of Section 262713 "Electricity Metering." [**Install**][**Make provision for installation by providing mounting space, brackets, and cable and conduit routing as well as**] the following:

a) Sensors.
b) BAS interface.
c) Kilowatt-hour meter.
d) Kilowatt-hour demand meter.

t. Capacities and Characteristics:

1) Power Rating: <**Insert number**> kVA.
2) Voltage Ratings: <**Insert primary voltage**> V - [**208Y/120**][**480Y/277**] V.
3) Taps: [**Comply with IEEE C57.12.26 requirements**]<**Insert values**>.
4) Transformer BIL (kV): [**Comply with IEEE C57.12.26 requirements**]<**Insert number**>.
5) Minimum Tested Impedance (Percent) at 85 deg C: [**2.50**][**2.87**][**4.03**][**5.75**]<**Insert number**>.
6) K-factor: <**Insert number**>.
7) Comply with FM Global Class No. 3990.
8) Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

u. Transformer Accessories:

1) Drain and filter connection.
2) Filling and top filter press connections.
3) Pressure-vacuum gauge.
4) Dial-type analog thermometer with alarm contacts.
5) Magnetic liquid level indicator with high and low alarm contacts.
6) Automatically resetting pressure-relief device. Device flow must be as recommended by manufacturer.[**With alarm contacts and manual bleeder.**]
7) Stainless steel ground connection pads.
8) Machine-engraved nameplate, made of anodized aluminum or stainless steel.
9) Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide [**with**][**without**] seal-in delay.

v. Control Network: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as native device.

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**2.5**]<**Insert value**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

C. Examine concrete bases for suitable conditions for transformer installation.

D. Preinstallation Checks:

1. Verify removal of shipping bracing after placement.
2. Remove sample of insulating liquid in accordance with ASTM D923. Insulating-liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:

a. Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
b. Acid Neutralization Number: ASTM D974.
c. Specific Gravity: ASTM D1298.
d. Interfacial Tension: ASTM D971.
e. Color: ASTM D1500.
f. Visual Condition: ASTM D1524.
g. Water in Insulating Liquids: Comply with ASTM D1533.
h. Power Factor or Dissipation Factor: ASTM D924.

E. Verify that grounding and bonding connections are in place. Ground (Earth) resistance may not exceed [**5 Ω**]<**Insert resistance in ohms**> at transformer location.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Communications Work: BICSI N1.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."
2. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.
3. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and IEEE C2.

D. Grounding and Bonding:

1. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
2. Fence and equipment connections may not be smaller than 4 AWG. Ground fence at gate posts and corner posts and at intervals not exceeding **10 ft (3 m)**. Bond gate sections to fence posts using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
4. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure.
5. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.

E. Connect low-voltage wiring.

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

F. Terminate medium-voltage cables in incoming section of transformers.

G. Interfaces with Other Work:

1. Identification: Provide labels for transformers and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Install transformers on cast-in-place concrete equipment base(s).
3. Provide vibration isolation and seismic control devices.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
b. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at transformer is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with the Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Medium-Voltage Surge Arrester Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.
2) Verify arresters are clean.
3) Verify that ground leads on devices are individually attached to ground bus or ground electrode.

b. Electrical Test:

1) Perform insulation-resistance test on arresters, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of

manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.

2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Liquid-Filled Transformer Field Tests:

a. Visual and Mechanical Inspection:

1) Test dew point of tank gases if applicable.
2) Inspect anchorage, alignment, and grounding.
3) Verify bushings are clean.
4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
5) Verify that liquid level in tanks is within manufacturer's published tolerances.
6) Perform specific inspections and mechanical tests recommended by manufacturer.
7) Verify presence of transformer surge arresters and that their ratings are as specified.
8) Verify that as-left tap connections are as specified.

b. Electrical Tests:

1) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index may not be less than 1.0.
2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
3) Measure core insulation resistance at 500 V(dc) if core is insulated and core ground strap is removable. Core insulation-resistance values may not be less than 1 MΩ at 500 V(dc).
4) Perform power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
5) Perform Optional Field Tests:

a) Perform turns-ratio tests at tap positions. Turns-ratio test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
b) Perform excitation-current test on each phase. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows different pattern.
c) Measure resistance of windings at tap connections, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
d) Perform applied-voltage test on line- and load-side windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9. This test is not required for single-phase transformers and for three-phase wye-wye-connected transformers.

6) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
7) Remove sample of insulating liquid in accordance with ASTM D923, and perform dissolved-gas analysis in accordance with IEEE C57.104 or ASTM D3612.

E. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain transformer equipment.

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.5 PROTECTION

A. After installation, protect transformer from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformers. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.
b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are

obtained.

4. Field Reports for Voltage Monitoring and Adjusting: Prepare written report covering monitoring performed and corrective action taken.

B. Infrared Scanning of Transformers: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies transformer equipment checked, testing technician, and equipment used, and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action. List results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 26 12 19 00

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SECTION 26 12 19 00A - LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of This Section Includes:

1. Metal-enclosed, low-voltage switchgear, with drawout power circuit breakers and metering and control accessories.

a. Switchgear structure.
b. Additional requirements for indoor switchgear.
c. Additional requirements for outdoor switchgear.
d. Circuit breakers.
e. Arc-flash limiting feeder circuit breakers.
f. Zone-selective interlocking.
g. Network protectors.
h. Surge suppression.
i. Control power supply, 120 V(ac).
j. Control power supply, 24 V(dc).
k. Instrumentation and control.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. <**Insert products installed, but not furnished**>.

D. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
4. Section 230923.13 "Energy Meters" for electricity meters for HVAC equipment.
5. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for submetering.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For switchgear. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for switchgear.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. For low-voltage switchgear.

a. System Power One-Line Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:

1) Frame size of circuit breakers.
2) Trip rating for circuit breakers.
3) Conduit and wire size for feeders.

b. Include plans, elevations, sections, shipping splits, and mounting details.
c. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
d. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
e. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
f. Indicate short-time and short-circuit current rating of switchgear assembly.
g. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
h. Include mimic-bus diagram.

C. Delegated Design Submittals: For low-voltage switchgear.

1. Comply with Section 260572 "Overcurrent Protective Device Short-Circuit Study" and Section 260573.16 "Coordination Studies."
2. For differential ground-fault protection scheme. Include wiring diagram of differential system along with test procedure recommended by UL 1558, using high-current injection equipment.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Submit evidence that switchgear is compatible with connected monitoring and control devices and systems specified in [**Section 260913 "Electrical Power Monitoring"**]<**Insert Section number and title for integrated controls**>.

1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of protocol.

B. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. For unloading and inspection, clearances, torque values, insulation-resistance testing, dielectric withstand-voltage testing, breaker testing, power factor testing, grounding, ground-fault protection testing, batteries and chargers testing, and system functional testing.

C. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. System Power Riser Diagram: For switchgear, using non-fugitive ink on high-quality paper. Post on wall at switchgear location.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner the following spare parts for repairing switchgear that are packaged with protective covering for storage on-site and identified with labels describing contents:

1. Drawout Circuit Breakers: One of each type and rating used for circuit breaker in switchgear.
2. Fuses: [**One**]<**Insert number**> for every [**three**]<**Insert number**> of each type and rating, but no fewer than three of each for the following:

a. Potential transformers.
b. Control power circuits.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchgear, packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Portable test set for testing functions of circuit-breaker, solid-state trip devices without removal from switchgear.
2. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
3. Racking handle to move circuit breaker manually between connected and disconnected positions.
4. Circuit-Breaker Removal Apparatus:

a. Floor Type: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
b. Overhead Type: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

5. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
6. Storage for Manual: Include rack or holder, near operating instructions, for copy of maintenance manual.

C. Consumable Items:

1. After completion of field quality control, startup, commissioning, adjusting, and closeout activities, replace air filters and refill fluid reservoirs.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Indoor Switchgear Storage: Store in dry, clean location, placed on level surface to prevent strain and possible distortion. During construction period, provide protection against dust, dirt, falling objects, dripping water, water, excessive moisture, and other possible causes of damage to equipment. Temporary covering may not restrict ventilation and may not be removed until equipment is ready for installation.[**Store indoor equipment within heated building.**][**Take special precaution to keep equipment sufficiently warm with adequate ventilation to prevent condensation during storage period. Install temporary heating if necessary.**]

B. When provisions for temporary power connection are provided as part of switchgear assembly, provisions must be included to prevent energization of primary buses or connections by means of backfeed through fuses or control power transformers connected to primary buses or connections.

C. If outdoor switchgear cannot be installed and energized, temporary power must be provided for operation of space heaters provided so as to prevent condensation of moisture within housing.

D. Ventilation openings must be left open to permit proper air circulation.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.4 LOW-VOLTAGE SWITCHGEAR

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**SAI Advanced Power Solutions/Switchboard Apparatus Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**SAI Advanced Power Solutions/Switchboard Apparatus Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

2.5 SYSTEM DESCRIPTION

A. Description: Metal-enclosed, low-voltage switchgear with drawout [**fused**][**fused, where indicated,**] power circuit breakers, with accessories and metering components.

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Comply with IEEE C37.20.1.
3. Listed and labeled as complying with UL 1558.
4. Listed and labeled for use as service entrance equipment.

2.6 PERFORMANCE REQUIREMENTS

A. Capacities and Characteristics:

1. Nominal System Voltage: [**480 V, three**][**480/277 V, four**][**240 V, three**][**208/120 V, four**] wire, 60 Hz.
2. Rated Maximum Voltage: [**254 V**][**508 V**][**635 V**].
3. Rated Power Frequency: 60 Hz.

4. Rated Insulation Level: Power frequency withstand must be not less than 2.2 kV(rms).
5. Rated Continuous Current:

    a. Main-Bus Continuous: [**1600 A**][**2000 A**][**3000 A**][**3200 A**][**4000 A**][**5000 A**].
    b. Vertical Section Bus Riser: Equal to frame size of low-voltage power circuit breaker connected to that riser.

6. Rated Short-Circuit Withstand Current: [**42 000 A(sym)**][**65 000 A(sym)**][**85 000 A(sym)**][**100 000 A(sym)**][**200 000 A(sym)**].
7. Short-Time and Short-Circuit Current: Match rating of integrated short-circuit current rating.

2.7 SWITCHGEAR STRUCTURE

A. Bus isolation barriers must be arranged to isolate line bus from load bus at main and tie circuit breaker. Extend section barriers between main and tie circuit breakers to rear of section.

B. Allow the following circuit-breaker functions to be performed when compartment door is closed:

1. Operate manual charging system.
2. Open and close circuit breaker.
3. Examine and adjust trip unit.
4. Read breaker nameplate.

C. Install instrument compartments when additional space is required for metering and instrumentation. Allow for routing of instrumentation, control and communications wires, and cables.

D. Switchgear Bus:

1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
2. Main Phase Bus: Uniform capacity entire length of assembly.
3. Neutral Bus: [**50**][**100**] percent of phase-bus ampacity unless otherwise indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
4. Ground Bus: Uniform capacity entire length of assembly, with pressure connector terminations for feeder and branch-circuit ground conductors, minimum size **1/4 by 2 inch (6 by 50 mm)**.
5. Vertical Section Bus Size: [**Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers**][**Fully rated to system continuous current, equal to horizontal bus**].
6. Bus Material and Connections:

    a. Phase- and Neutral-Bus Material:

        1) Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
        2) Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.
        3) Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

    b. Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus.
    c. Use copper for connecting circuit-breaker line to copper bus.
    d. Contact Surfaces of Buses: Silver plated.

e. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.

7. Neutral Disconnect Link: Bolted, uninsulated, bus, arranged to connect neutral bus to ground bus.
8. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
9. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.

   a. Sprayed Insulation Thickness: **3 mil (0.08 mm)**, minimum.
   b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

E. Circuit-Breaker Compartment:

1. Drawout Features: Circuit-breaker mounting assembly equipped with racking mechanism to position circuit breaker and hold it rigidly in connected, test, disconnected, and withdrawn positions. Include the following features:

   a. Provide circuit-breaker racking system with positive stops at connected, test, disconnected, and withdrawn positions.
   b. Interlocks: Prevent racking of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
   c. Circuit-Breaker Positioning: Permit racking of open circuit breaker to or from connected, test, and disconnected positions only when compartment door is closed unless live parts are covered by full dead-front shield. Permit manual withdrawal of open circuit breaker to position for removal from structure. When compartment door is open, status for connection devices for different positions includes the following:

      1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
      2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

   d. Primary Disconnect: Mount on stationary part of compartment. Disconnect must consist of set of contacts extending to rear through insulating support barrier, and of corresponding moving finger contacts on power circuit-breaker studs, which engage in only connected position. Assembly must provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on fingers. Load studs must connect to bus extensions that terminate in solderless terminals in rear cable compartment.
   e. Secondary Disconnect: Floating terminals mounted on stationary part of compartment that engage mating contacts at front of breaker.
   f. Provide verification of positive ground contact between circuit breaker and its compartment when accessory cover is removed while circuit breaker is in connected, test, disconnected, and withdrawn positions.
   g. Place 2400 A frame and larger circuit breakers at bottom of switchgear.

F. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:

1. Utility metering compartment that complies with utility-company requirements.
2. Bus transition sections.
3. Incoming-line pull sections.
4. Hinged front panels for access to metering, accessory, and blank compartments.

G. Pull Boxes: Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and

side covers and with ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.

1. Set pull box back from front to clear circuit-breaker lifting mechanism.
2. Pull-Box Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
3. Cable Supports: Arranged to ease cabling and adequate to support cables, including those for future installation.

2.8 ADDITIONAL REQUIREMENTS FOR INDOOR SWITCHGEAR

A. Enclosure Rating: Indoor.

B. Enclosure Material: Steel.

C. Enclosure Finish: IEEE C37.20.1, manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

D. Enclosure Rear Panels: Removable and hinged, to allow access to rear interior of switchgear.

2.9 ADDITIONAL REQUIREMENTS FOR OUTDOOR SWITCHGEAR

A. Outdoor Enclosure Rating: UL 1558.

B. Outdoor Enclosure Description: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating

C. Outdoor Enclosure Material: [**Steel**][**12 gage, ASTM A240, Type 304 or 304L stainless steel**].

D. Outdoor Enclosure Finish:

1. Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
2. Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands [**120**][**480**] hours of exposure to salt-spray test specified in ASTM B117, without loss of paint or release of adhesion of paint primer coat to metal surface in excess of **1/16 inch (1.6 mm)** from test mark. Scribed test mark and test evaluation must be conducted in accordance with ASTM D1654, with rating of not less than 7 in accordance with Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized sheet steel must be coated with manufacturer's standard zinc-rich paint.
3. Front and rear doors must be provided with stainless steel padlockable vault handles with three-point catch. Bases, frames, and channels of enclosure must be corrosion resistant, fabricated of ASTM A240 Type 304 or 304L stainless steel. Base must include part of enclosure that is within **3 inch (75 mm)** of concrete pad. Coat enclosure, including bases, must be ASTM D1535 light gray No. 61 or No. 49. Coating system must comply with IEEE C57.12.29 for stainless steel.

E. Features:

1. Structural design and anchorage adequate to resist seismic and wind loads specified in Section 260011 "Facility Performance Requirements for Electrical."
2. Sloping, standing-seam type, insulated roof panels.
3. Mount shipping group on integral base frame as complete weatherproof unit.

4. Aisle-Less Construction: Vertical sections must have the following:

    a. Hinged front door with padlocking provisions.
    b. Interior light with switch.
    c. Weatherproof duplex receptacle.
    d. With draft-stop where busway exits vertical section.
    e. Vertical Section Space Conditioning: Provide outside-air openings with insect and rodent screens and filters; arranged to permit air circulation while excluding insects, rodents, and exterior dust. Provide thermostatically controlled space heaters operating at one-half or less of rated voltage.

5. Common Internal Aisle-Type Construction:

    a. With aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
    b. Aisle access doors with outside padlocking provisions and interior panic latches.
    c. Vaporproof [**LED aisle lights**][**fluorescent aisle lights with low-temperature ballasts**], controlled by wall switches at entrances.
    d. GFCI duplex receptacles, minimum of two, located in aisle.
    e. Interior Space Conditioning:

        1) Forced-air aisle ventilation with thermostatically controlled vent fans, interlocked with aisle space heaters operating at one-half or less of rated voltage. Provide outside-air openings with insect and rodent screens and filters; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
        2) Air conditioned.

2.10 CIRCUIT BREAKERS

A. Drawout type, unfused, power operated, with electromechanical or electronic trip devices. Comply with IEEE C37.13, IEEE C37.13a, and UL 1066.

B. Ratings: For continuous, interrupting, and short-time current ratings for circuit breakers; voltage and frequency ratings same as switchgear. Comply with IEEE C37.16.

1. Circuit breakers must have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85 000 A, whether or not equipped with instantaneous trip protection.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

1. Normal Closing Speed: Independent of both control and operator.
2. Slow Closing Speed: Optional with operator for inspection and adjustment.
3. Stored-Energy Mechanism: [**Manually charged**][**Electrically charged**][**Electrically charged, and operator's choice of manual charging**].

    a. Operating Handle: One for each circuit breaker capable of manual operation.
    b. Electric Close Button: One for each electrically operated circuit breaker.

4. Provide interlock to discharge stored energy mechanism before circuit breaker can be withdrawn from its compartment.
5. Operation counter.

D. Operator Display: Located on face of circuit breaker.

1. Electrical operation buttons to open and close circuit breaker.[**Provide clear lockable cover over buttons.**]
2. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices. Energized or hot condition must be indicated by red light. De-energized, open, and safe condition must be indicated by green light.
3. Indicator to show position of circuit-breaker contacts, status of closing springs, and circuit-breaker position in its compartment.
4. Provide "Charged-not OK to close" indicator when closing springs are charged but circuit breaker is not ready to close.
5. Computer Display: One or more [**touchscreen**]computer displays with dedicated CPU, to display data that are generated for transmission via Ethernet connection. Display the following functions:

    a. Circuit-breaker status and circuit-breaker controls status.
    b. Onboard meters.
    c. User settings for overcurrent protection and undervoltage protection.
    d. <**Insert features**>.

E. Overcurrent Protective Tripping: Microprocessor-based, programmable, time-current shaping adjustments; complete with current transformers and sensors and the following features:

1. Programmable functions independent of each other in both action and adjustment.

    a. Long-time setting.
    b. Long-time-delay with selectable I2T or I4T curve shaping.
    c. Short-time setting.
    d. Short-time-delay with flat or selectable I2T curve shaping.
    e. Instantaneous trip.

2. Field-adjustable, time-current characteristics.
3. Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or combination of these methods.
4. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
5. Pickup Points:

    a. Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I2T operation.
    b. Five minimum, for instantaneous-trip functions.

F. Ground-Fault Protection:

1. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup.
2. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
3. Test Form: Provide ground-fault relays with information sheets describing system-testing instructions, and with test form; comply with UL 1558.

G. Undervoltage Trip Devices:

1. Instantaneous, with adjustable pickup voltage.
2. Adjustable time-delay and pickup voltage.

H. Shunt-Trip Devices.

I. Metering:

1. Accuracy: [**0.5**][**1.0**] percent of reading, complying with ANSI C12.20.
2. Values must be RMS average over period of one second.

a. Current: Each phase, [**neutral**]and three-phase average.
b. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
c. Active Power (kW): [**Each phase and**]three-phase total.
d. Reactive Power (kVAR): [**Each phase and**]three-phase total.
e. Apparent Power (kVA): [**Each phase and**]three-phase total.
f. Power Factor: [**Each phase and**]three-phase total.
g. Active Energy (kWh): Three-phase total.

J. Auxiliary Contacts:

1. Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.
2. Spare auxiliary switches, at least two, unless otherwise indicated. Switches must consist of two Type A and two Type B contacts wired through secondary disconnect devices to terminal block in stationary circuit-breaker compartment.

K. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

L. Padlocking Provisions: For installing at least three padlocks on circuit breakers to secure its enclosure and prevent movement of drawout mechanism.

M. Mechanical Interlocking of Circuit Breakers: Uses mechanical tripping lever or equivalent design and electrical interlocks.

N. Key Interlocks: Arranged to prevent opening or closing of interlocked circuit breakers, except in specified sequence. Include mountings and hardware for future installation of key interlocks.

2.11 ARC-FLASH LIMITING FEEDER CIRCUIT BREAKERS

A. Feeder circuit breakers must be without current-limiting fuses, listed as complying with UL 1066.

B. Short-circuit withstand current rating must be 200 kA.

C. Equip arc-flash limiting feeder circuit breakers with Arc-Flash Maintenance Setting switch for use as temporary arc-flash incident energy-reduction device during maintenance activities on that feeder.

1. Provide manual switch on compartment door to switch circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce danger from potential arc-flash at downstream equipment.
2. Provide lock feature for switch so that it may be locked in either off or on maintenance-mode position.
3. Provide blue LED indicating light to indicate that switch is in maintenance mode.
4. Provide dry relay contacts on switches for annunciation of switch position.

2.12 ZONE-SELECTIVE INTERLOCKING

A. Trip units for indicated circuit breakers must include zone-interlocking capability for short-time delay and ground-fault delay trip functions for system coordination and arc energy reduction. Zone-interlocking system must restrain tripping of upstream circuit breaker and allow circuit breaker closest to fault to trip with no intentional time delay. In event that downstream breaker does not trip, upstream breaker must trip after preset time delay.[**Zone-interlock system must be factory wired and tested for circuit breakers within switchgear.**]

2.13 NETWORK PROTECTORS

A. Comply with IEEE 57.12.44 and IEEE C37.20.1. Switch must comply with UL 1066.

1. Dead-front, drawout design with externally mounted fuses, using hand-cranked rail system. Include mechanical interlocks to prevent racking in and racking out when protector is closed.
2. Locate relay and control panel on separate drawout module.
3. Protector Operator: [**Spring-close**][**and**][**or**][**stored-energy**] mechanism, rated to close on [**25 000 A(rms sym)**][**40 000 A(rms sym)**] load.
4. Program relay with factory-default values. Make provisions to field adjust these values using relay calibration procedures. Include antipumping program to lock protector open under abnormal conditions.
5. Include current-limiting fuses on network side of protector for protection against switchboard bus faults.

B. Controls must be via microprocessor-based, three-phase network relay, with the following features and functions:

1. Protector control must use positive and negative sequence-based algorithm for current and voltage.
2. Close protector if positive sequence power flows into network. Adjustable closing range must be from 0.5 to 3.5 V in phase difference between network and transformer voltages.
3. Trip protector if there is net, three-phase, reverse power flow through protector. Trip protectors must be adjustable from 0.05 to 5 percent of continuous-current rating of current transformers within protector.
4. Trip protector if there is flow of reverse magnetizing current to its associated transformer.
5. Relay parameters and W or VAR trip values must be field adjustable.
6. Protector may not open under fault on network side of protector.
7. Include auxiliary contacts and control wiring for use with remote pilot devices that provide remote trip and lockout functions in low-voltage switchgear. Include [**two**]**<Insert number>** spare auxiliary contacts and equal number of N.O. and N.C. types.

C. Communicate the following network relay parameters:

1. Current in each phase.
2. Phase-to-phase and phase-to-neutral voltages.
3. Three-phase W, VAR, and VA.
4. Frequency.
5. Power factor.
6. Network relay set points.

2.14 SURGE SUPPRESSION

A. Factory Installed: Integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the

following features and accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at 5 A 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5. Surge counter.

B. Field Mounted: Complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits." Include the following features and accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at 5 A 250 V(ac), one N.O. and one N.C., for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5. Surge counter.

2.15 CONTROL POWER SUPPLY, 120 V(ac)

A. Control Power Transformer: Supply 120 V control circuits through dry-type control power transformers, include secondary disconnect devices.

1. Place transformers larger than 3 kVA in separate compartments at bottom of vertical section, including related primary and secondary fuses.
2. Two control power transformers in separate compartments with necessary interlocking relays; transformers connected to line side of associated main circuit breaker.

    a. Secondary windings connected through relay(s) to control bus to affect automatic transfer scheme.
    b. Secondary windings connected through internal automatic transfer switch to switchgear control power bus.

3. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

2.16 CONTROL POWER SUPPLY, 24 V(dc)

A. System Requirements: Battery must have number of cells and ampere-hour capacity based on initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded. Battery system capacity must be as recommended by switchgear manufacturer to operate circuit breakers for intended duty.

B. Battery: [**Standard VRLA**][**Premium VRLA**][**Vented NiCd,**] batteries, with battery disconnect and overcurrent protective device.

C. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.[**Rate battery rack, cell supports, and anchorage for seismic requirements.**]

D. Accessories:

1. Thermometers with specific-gravity correction scales.
2. Hydrometer syringes.
3. Set of cell numerals.

E. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with AC input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.

1. DC ammeter.
2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by N.O. push-button contact.
4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell, and equalizing charge at 2.33 V per cell.
5. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.
6. AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. Automatic charger operation must resume after loss of AC power supply for interval.
7. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. Device must regulate charging current but may not disconnect charger from either battery or AC supply.
8. Charger's Audible Noise: Less than 26 dB(A-weighted).

2.17 INSTRUMENTATION AND CONTROL

A. Power Distribution Equipment must be web enabled, direct connected to Local Area Network (LAN) or Intranet.

B. Ethernet Connectivity:

1. Install multipoint, TIA-485 MODBUS serial communications network within switchgear to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network must be wired to Ethernet gateway in switchgear. Gateway must be web enabled, with integral network port and embedded web server with factory-configured firmware and HTML-formatted web pages for viewing of power monitoring and equipment status information from switchgear devices equipped with digital communication ports.
3. LAN must consist of multipoint, TIA-485 MODBUS serial communication network to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network must be connected to Ethernet server that functions as gateway and server, providing data access via [**10 Base-T**][**100 Base-T**][**100 Base-TX**][**100 Base FX**] LAN.
4. Server Configuration:

a. Initial network parameters set using standard web browser. Connect via local operator interface, or TIA-1096 Type 8P8C jack accessible from front of equipment.
b. Network server must be factory programmed with embedded HTML-formatted web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of TIA-485 network; with internal memory management information pages for viewing using standard web browser.
c. Password-protected login, with password administration accessible from LAN using standard web browser.
d. Operating Software: Suitable for local access; firewall protected.

5. All serial communications devices within equipment must be addressed at factory and tested.

C. Instrument Transformers: Comply with IEEE C57.13. Instrument transformers may not be used to power space conditioning equipment associated with outdoor switchgear, of for power to convenience receptacles and lighting.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 Accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and Accuracy class suitable for connected relays, meters, and instruments.

D. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.

1. Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.
2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase[**and phase-to-neutral**] voltages.
3. Ammeters: Cover expanded scale range of bus rating plus 10 percent.
4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a. Operation: Counts and records succession of pulses entering two channels.
b. Housing: Drawout, back-connected case arranged for semiflush mounting.

E. Power Monitoring: Separately mounted, modular, permanently installed, solid-state, digital I/O multifunction metering instrument for power and energy metering and monitoring, complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue-related metering from unauthorized and accidental changes.
3. Comply with IEC 60529 degree of protection code of IP65 for front of meter, and code of IP30 for body.
4. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
5. Accuracy:

a. Comply with ANSI C12.20, Class 0.5.
b. Neutral Current Measurement: Not more than 0.65 percent.

c. Power Factor: 1.0 percent.
d. Frequency: 0.1 percent.
e. THD: 1.0 percent.
f. Waveform Sampling: 64 per cycle.

6. Data Link: Ethernet connectivity specified in this article.
7. Meter Physical Characteristics:

a. Display: Backlit LCD with antiglare and scratch-resistant lens.
b. Display of Metered Values: One screen to show at least [**three**]<**Insert number**> user-selected values displayed at same time. Selections available to display must include the following:

1) All meters.
2) Measurements.
3) THD.
4) Energy.
5) Demand.
6) Minimum and maximum values.
7) Power demand.

8. Sampling Rate: Continuously sample and record voltage and current at rate not less than [**64**]<**Insert number**> samples per cycle, simultaneously on voltage and current channels of meter.
9. Meters:

a. Instantaneous, RMS:

1) Current: Each phase, [**neutral**]and three-phase average.
2) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
3) Active Power (kW): [**Each phase and**]three-phase total.
4) Reactive Power (kVAR): [**Each phase and**]three-phase total.
5) Apparent Power (kVA): [**Each phase and**]three-phase total.
6) Power Factor: [**Each phase and**]three-phase total.

b. Energy:

1) Active Energy (kWh): Three-phase total.

c. Demand, Derived from Instantaneous RMS Meters:

1) Current: Present and maximum.
2) Active: Present and maximum.
3) Reactive: Present and maximum.
4) Apparent: Present and maximum/

d. Power Quality Measurements:

1) THD: Current and voltage from measurements simultaneously from same cycle, as can be calculated from specified sampling rate.

10. I/O: Two optically isolated digital outputs for KYZ pulsing or control. Output signal characteristics must be 150 mA at 200 V.

a. KYZ Pulse: Generate standard KYZ pulses for user-defined increment of metered active energy as follows:

1) User-defined pulse output, associated with kWh.
2) User-defined pulse output, associated with kVARh.

b. <**Insert control function**>.

11. Capacities and Characteristics:

a. Circuit Connections:

1) Voltage: Measurement autoranging, 60 to 400 V(ac rms) L-N.[**Connect directly to low-voltage (600 V and less) without using voltage transformers.**][**Connect to instrument-grade potential transformers secondary at 120 V.**] Meter impedance must be 2 MΩ L-L or greater.
2) Overload Tolerance: 1500 V(ac rms) continuously.
3) Current: Connect to instrument-grade current transformer with metering range of 5 mA to 6 A. Overcurrent tolerance of instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
4) Frequency: 45 to 65 Hz.
5) Time: Input from GPS receiver to synchronize internal clock of instrument and to time-synchronize this instrument with network to deviation of not greater than 1 ms.

2.18 POWER TRANSFER CONFIGURATIONS

A. Factory-installed and -tested controls of circuit breakers to accomplish automatic transfer controls for switchgear having two power sources.

B. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

C. Control Wiring:

1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Install plugs in control wiring at shipping splits.

D. Two-Breaker Transfer Control:

1. Two-breaker transfer control must provide for switchgear assembly with common load bus and two normally energized medium-voltage power sources, designated "normal" and "standby," connected to load bus. Circuit breakers connecting two power sources to load bus must be controlled by microprocessor-based automatic transfer control. Power for transfer control must be from voltage sensing transformers.
2. In automatic mode, load bus is connected to normal power source. When normal source fails, control must automatically open normal power source and close standby source circuit breaker.
3. Sequence of Operation:

a. Default operation must be with normal source main breaker closed and standby main breaker open. On detection of undervoltage to line side of normal main breaker and after field-adjustable time delay, that main breaker must open and after additional field-adjustable time delay, standby breaker must close restoring power to facility.
b. On restoration of voltage to line side of normal main breaker and after field-adjustable time delay, standby main breaker must open and after field-adjustable time delay, normal main

breaker must close.

4. Field-Adjustable Transfer Parameters:

   a. Delay transfer from normal power source to standby power source and from standby power source to normal source. Time delay is to allow load voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.
   b. Delay initiation of transfer sequence. Time delay is recommended to override momentary power outage or voltage fluctuation. Delay range: zero seconds to 120 seconds.
   c. Delay transfer from standby power source to normal power source. Delay range: zero seconds to 30 minutes.
   d. A relay with contact that changes state when power is available on normal source and relay with contact that changes state when power is available on standby source.

5. Controls and Indicators: Besides delay setting controls, provide the following:

   a. Interlocks or relay control to prevent transfer when either of two controlled circuit breakers are tripped due to overcurrent or ground fault.
   b. Three-position selector switch to select normal source: Source 1, Source 2, or none.
   c. Transfer-control automatic and manual selector.

      1) Interlock must prevent paralleling of two power sources in manual mode.

   d. Open-close control switch for manual electrical operation of controlled circuit breakers.
   e. Selector to place control into programming mode.
   f. Circuit-breaker control switch for normal and standby source breakers, providing open and close operation.
   g. Push-button to initiate manual retransfer to normal source when transfer controller is in automatic mode.
   h. Meters and display to show the following:

      1) Voltage and frequency of both sources.
      2) A multiline display showing the following:

         a) Set points of timers, and voltage pickup and dropout set points.
         b) Date, time, and reason for at least last 10 transfers. Display may show information for one transfer at time using scrolling control, with others held in memory.
         c) When control system is in transferring process, display must show delay countdown in seconds.

   i. LED indicator lights to show the following:

      1) Normal source available.
      2) Standby source available.
      3) Normal source connected.
      4) Standby source connected.
      5) Load bus energized.

6. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
7. Voltage Sensing Relays: Microprocessor-based ANSI No. 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

E. Three-Breaker Transfer Control:

1. Switchgear assembly, with two normally energized, medium-voltage power sources designated "Main 1" and "Main 2" connected to load bus. N.O. bus tie circuit breaker can tie two load buses. Three circuit breakers must be controlled by microprocessor-based automatic-transfer control. Power for transfer control must be from voltage sensing transformers.
2. In automatic mode, on loss of voltage to line side of source, that main breaker must open and then bus tie must close. On restoration of power to previously failed main breaker, bus tie must open and open main must close.
3. Sequence of Operation:

    a. Default operation must be with main breakers closed and bus tie breaker open. On detection of undervoltage to line side of main breaker and after field-adjustable time delay, that main breaker must open and after additional field-adjustable time delay, bus tie breaker must close, restoring power to failed bus.
    b. On restoration of voltage to line side of previously failed main breaker and after field-adjustable time delay, tie breaker must open and after field-adjustable time delay, previously failed main breaker must close.

4. Field-Adjustable Transfer Parameters:

    a. Delay opening of failed main and closing of bus tie. Time delay is to allow load voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.
    b. Delay initiation of transfer sequence. Time delay is recommended to override momentary power outage or voltage fluctuation. Delay range: zero to 120 seconds.
    c. Delay opening of bus tie and closing of previously failed main. Time delay is to allow bus voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.

5. Controls and indicators must include the following in addition to delay setting controls:

    a. Interlocks or relay control to prevent transfer when any of three controlled circuit breakers trip due to overcurrent or ground fault.
    b. Transfer control automatic and manual selector.

        1) Interlock that prevents paralleling of two mains in manual or automatic mode.

    c. Open-close control switch for manual electrical operation of controlled circuit breakers.
    d. Selector must place control into programming mode.
    e. A relay with contact that changes state when power is available on both mains and relay with contact that changes state to indicate open main and when bus tie is closed.
    f. Push-button to initiate manual retransfer to previously failed source when transfer controller is in automatic mode.
    g. Meters and display must show the following:

        1) Voltage and frequency at line side of both mains.
        2) A multiline display must show following:

            a) Set points of timers, and voltage pickup and dropout set points.
            b) Date, time, and reason for at least last 10 transfers. Display may show information for one transfer at time using scrolling control, with others held in memory.
            c) When control system is in transferring process, display must show delay countdown in seconds.

    h. LED indicator lights must show the following:

1) Main source available.
2) Main source unavailable.
3) Main closed.
4) Main open.
5) Bus tie open or closed.

6. Voltage transformers must have primary and secondary protection and disconnecting means for sensing functions and control power.
7. Voltage Sensing Relays: Microprocessor-based ANSI No. 27/47 voltage detection relays for three-phase undervoltage protection and negative-sequence voltage protection.

2.19 DIFFERENTIAL GROUND-FAULT PROTECTION

A. Description: Ground-fault protection system for three-phase, four-wire switchgear having multiple sources must be devised by manufacturer to insure that proper main or tie breaker(s) operate properly in normal and emergency conditions. Switchgear must include additional current transformers, ground-fault relays, interlocks, wiring, and accessories to avoid nuisance tripping of circuit breakers connected to main bus of switchgear. Ensure that the following occurs on main bus:

1. A ground fault at location in switchgear must trip system.
2. Combination of normal current flow and ground-fault current flow must trip system.
3. Circulating currents through neutral due to multiple grounds and sources external to immediate low-voltage power sources may not trip system.
4. System may not trip if there is no ground fault, during normal current flow.
5. System may not trip due to large single-phase currents.

B. Relays: Comply with IEEE C37.90, with test blocks and plugs.

C. Control Wiring:

1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Install plugs in control wiring at shipping splits.

2.20 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: [**Owner will engage**][**Engage**] qualified testing agency to evaluate low-voltage switchgear.

C. Factory Tests and Inspections: Test and inspect low-voltage switchgear, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C37.20.1 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance on control units. Drawout circuit breakers need not be tested in assembly if they are tested separately.

1. Dielectric Tests: Perform power-frequency withstand tests to demonstrate ability of insulation system to withstand voltages listed in IEEE C37.20.1. Voltage must be increased gradually from zero to required test value within 5 to 10 seconds and must be held at that value for one minute.
2. Perform mechanical operation tests to ensure proper functioning of operating mechanism,

mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
3. Test effectiveness of grounding of metal-case instrument transformer frame or case.
4. Verify that control wiring is correct by verifying continuity. Perform electrical operation of component devices to ensure that they function properly and in intended sequence.
5. Perform control wiring insulation tests.
6. Verify correct polarity of connections between instrument transformers and meters and relays.

D. Serial communications devices within equipment must be addressed at factory and tested to verify reliable communications to equipment's Ethernet gateway.

E. Nonconforming Work:

1. Low-voltage switchgear assembly will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions where switchgear will be installed.

D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be [**5 Ω**]<**Insert Ω**> at switchgear location.

E. On delivery of switchgear and prior to unloading, inspect equipment for damage.

1. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's published instructions.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with bill of materials to verify that shipment is complete. Verify that switchgear and accessories comply with manufacturer's published instructions and Shop Drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

F. Handling:

1. Handle switchgear, in accordance with manufacturer's published instructions; avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Protect switchgear compartments against entrance of dust, rain, and snow.
3. Transport switchgear upright, to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
4. Use spreaders or lifting beam to obtain vertical lift and to protect switchgear from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
5. Do not damage structure when handling switchgear.

G. Proceed with installation only after examinations are complete and unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."

B. Comply with requirements for vibration isolation and seismic-control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and [**Section 260548 "Vibration and Seismic Controls for Electrical Systems."**][**Section 260548.16 "Seismic Controls for Electrical Systems."**]

C. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Connections at Exterior Locations:

1. Install tinned bare copper conductors not smaller than 4/0 AWG, for ground conductors buried not less than **30 inch (765 mm)** below grade interconnecting grounding electrodes.
2. Bond surge arrester and neutrals directly to switchgear enclosure and then to grounding electrode system with bare copper conductors, sized as indicated.
3. Keep lead lengths as short as practicable with no kinks or sharp bends.
4. Make joints in grounding conductors and loops by exothermic weld or compression connector.
5. Fence and equipment connections may not be smaller than 4 AWG.
6. Ground fence at gate posts and corner posts and at intervals not exceeding **10 ft (3 m)**.
7. Bond gate sections to fence posts using **1/8 by 1 inch (3 by 25 mm)** [**tinned,**]flexible braided copper strap and clamps.

C. Terminate grounding and bonding conductors on common equipment grounding terminal on switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.

D. Complete switchgear grounding and surge-protector connections prior to making other electrical connections.

3.4 IDENTIFICATION

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

C. Compartment Nameplates: [**Engraved, laminated-acrylic**][**Engraved, melamine plastic**][**Preprinted aluminum signs**], as described in Section 260553 "Identification for Electrical Systems," for compartments, mounted with corrosion-resistant screws.

D. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as selected by Architect.
3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

E. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce **3.5 by 5 inch (76 by 127 mm)** self-adhesive equipment label for work locations included in analysis.
2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce **3.5 by 5 inch (76 by 127 mm)** self-adhesive equipment label for work locations included in analysis. Labels must be machine printed, with no field-applied markings.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

b. Labels must be machine printed, with no field-applied markings.

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B and NETA ATS.
2. After installing switchgear and after electrical circuitry has been energized, test for compliance

with requirements.

3. Perform visual and mechanical inspections and electrical tests stated in NETA ATS. Certify compliance with test parameters.
4. Visual and Mechanical Inspection:

    a. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study[**, as well as to circuit breaker's address in control network**].
    b. Verify that current and voltage transformer ratios correspond to Drawings.
    c. Inspect bolted electrical connections for high resistance using one of the following two methods:

        1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

    d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

        1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
        2) Make key exchange with devices operated in off-normal positions.

    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Inspect insulators for evidence of physical damage or contaminated surfaces.
    g. Verify correct barrier and shutter installation and operation.
    h. Exercise active components.
    i. Inspect mechanical indicating devices for correct operation.
    j. Verify that filters are in place and that vents are clear.
    k. Perform visual and mechanical inspection of instrument transformers in accordance with "Instrument Transformer Field Tests" Paragraph.
    l. Inspect control power transformers.

        1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
        2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
        3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

5. Electrical Tests:

    a. Perform DC voltage insulation-resistance tests on bus sections, phase-to-phase and phase-to-ground, for one minute. If bus temperature is other than plus or minus 20 deg C, adjust resulting resistance as provided in NETA ATS, Table 100.11.

        1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.1.
        2) Do not proceed to dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform dielectric withstand voltage test on bus sections, phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric withstand test, test specimen is considered to have passed test.

c. Perform insulation-resistance tests on control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate applied voltage, follow manufacturer's published instruction.

1) Minimum insulation-resistance values of control wiring may not be less than 2 MΩ.

d. Control Power Transformers:

1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and windings-to-ground. Insulation-resistance values of winding insulation must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.1.
2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to rated secondary voltage source. Verify correct potential at devices.
3) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.
4) Verify correct function of control transfer relays located in switchgear with multiple control power sources.

e. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing primary winding with system voltage.

f. Perform current-injection tests on entire current circuit in switchgear sections.

1) Perform current tests by secondary injection with magnitudes such that minimum 1.0 A current flows in secondary circuit. Verify correct magnitude of current at devices in circuit.
2) Perform current tests by primary injection with magnitudes such that minimum 1.0 A current flows in secondary circuit. Verify correct magnitude of current at devices in circuit.

g. Perform system function tests in accordance with "System Function Tests" Paragraph.
h. Verify operation of space heaters.
i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from sources.

D. Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, and grounding.
c. Verify that maintenance devices are available for servicing and operating breaker.
d. Verify unit is clean.
e. Verify that arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
h. Perform mechanical operator and contact alignment tests on both breaker and its operating mechanism in accordance with manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings in accordance with coordination study provided by Owner.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across open poles. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than Table 100.1 or manufacturer's published instructions must be investigated.
b. Measure contact resistance across power contacts of circuit breakers. Drop values for μΩ or mV(dc) may not exceed high levels of normal range as indicated in manufacturer's published data. In absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Determine long-time pickup and delay by primary current injection. Long-time pickup values must be as specified, and trip characteristic may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are unavailable, trip times may not exceed value shown in NETA ATS, Table 100.7.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values must be as specified, and trip characteristic may not exceed manufacturer's published time-current tolerance band.
e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values must be as specified, and trip characteristic may not exceed manufacturer's published time-current tolerance band.
f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values must be as specified and within manufacturer's published tolerances. In absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of trip unit by means of secondary injection. Pickup values and trip characteristic must be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must comply with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
j. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip-unit battery condition. Reset trip logs and indicators. Auxiliary features must operate in

accordance with manufacturer's published data.

k. Verify operation of charging mechanism. Charging mechanism must operate in accordance with manufacturer's published data.

E. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data complies with Contract Documents.
b. Inspect physical and mechanical condition.
c. Verify correct connection of transformers with system requirements.
d. Verify that adequate clearances exist between primary and secondary circuit wiring.
e. Verify that unit is clean.
f. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

g. Verify that required grounding and shorting connections provide contact.
h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
i. Verify correct primary and secondary fuse sizes for voltage transformers.
j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Perform insulation-resistance test of current transformers and secondary wiring for ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's published instructions. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.5.
b. Perform polarity test on current transformers in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.
c. Perform ratio-verification test using voltage or current method in accordance with IEEE C57.13.1. Ratio errors must be in accordance with IEEE C57.13.
d. Perform excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1. Excitation results must match curve supplied by manufacturer or be in accordance with IEEE C57.13.1.
e. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1. Measured burdens must be compared to, and must match, instrument transformer ratings.
f. Perform insulation-resistance tests on primary winding with secondary grounded. Test voltages must be in accordance with NETA ATS, Table 100.5.
g. Perform dielectric withstand tests on primary winding with secondary grounded. Test voltages must be in accordance with NETA ATS, Table 100.9.
h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
i. Verify that current transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3. That grounding point should be located

as specified by Engineer in Project Drawings.

3. Electrical Tests of Voltage Transformers:

   a. Perform insulation-resistance tests, winding-to-winding and windings-to-ground. Test voltages must be applied for one minute in accordance with NETA ATS Table 100.5. For units with solid-state components that cannot tolerate applied voltage, follow manufacturer's published instructions. Investigate and correct values of insulation resistance less than manufacturer's published instructions or NETA ATS, Table 100.5.
   b. Perform polarity test on transformers to verify polarity marks or H1-X1 relationship as applicable. Polarity results must agree with transformer markings.
   c. Perform turns-ratio test on tap positions. Ratio errors must be in accordance with IEEE C57.13.
   d. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared to, and must match, instrument transformer ratings.
   e. Perform dielectric withstand test on primary windings with secondary windings connected to ground. Dielectric voltage must be in accordance with NETA ATS, Table 100.9. Test voltage must be applied for one minute. If no evidence of distress or insulation failure is observed by end of total time of voltage application during dielectric withstand test, primary windings are considered to have passed test.
   f. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use test equipment manufacturer's published data.
   g. Verify that voltage transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3. Test results must indicate that circuits are grounded at only one point.

F. Ground-Resistance Test:

1. Visual and Mechanical Inspection:

   a. Verify that ground system complies with Contract Documents and with Article 250, "Grounding and Bonding," in NFPA 70.
   b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections must be free of corrosion.
   c. Inspect bolted electrical connections for high resistance using one of the following two methods:

      1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

   d. Inspect anchorage.

2. Electrical Tests:

   a. Perform fall-of-potential or alternative test in accordance with IEEE 81 on main grounding electrode or system. Resistance between main grounding electrode and ground must be no more than [**5 Ω**][**maximum ground-resistance value specified in "Examination"**

Article].

b. Perform point-to-point tests to determine resistance between main grounding system and major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 Ω. Compare equipment nameplate data with the Contract Documents.
c. Inspect physical and mechanical condition.
d. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

G. Metering Devices Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
d. Verify that unit is clean.
e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

a. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
b. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
c. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
d. Verify that current transformer and voltage transformer secondary circuits are intact. Test results must confirm integrity of secondary circuits of current and voltage transformers.

H. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision,

and rated control voltage.

b. Verify operation of LEDs, display, and targets.
c. Record passwords for each access level.
d. Clean front panel and remove foreign material from case.
e. Check tightness of connections.
f. Verify that frame is grounded in accordance with manufacturer's published instructions.
g. Set relay in accordance with results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
h. Download settings from relay. Print copy of settings for report and compare settings to those specified in coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from circuits to grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of relay meter functions.
c. Check functional operation of elements used in protection scheme as follows:

1) ANSI No. 2/62, Timing Relay:

a) Determine time delay.
b) Verify operation of instantaneous contacts.

2) ANSI No. 24, Volts/Hertz Relay:

a) Determine pickup frequency at rated voltage.
b) Determine pickup frequency at second voltage level.
c) Determine time delay.

3) ANSI No. 25, Sync Check Relay:

a) Determine closing zone at rated voltage.
b) Determine maximum voltage differential that permits closing at zero degrees.
c) Determine set points of live line, live bus, dead line, and dead bus.
d) Determine time delay.
e) Verify control functions of dead bus/live line, dead line/live bus, and dead bus/dead line.

4) ANSI No. 27, Undervoltage Relay:

a) Determine dropout voltage.
b) Determine time delay.
c) Determine time delay at second point on timing curve for inverse time relays.

5) ANSI No. 32, Directional Power Relay:

a) Determine minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Determine time delay.
e) Verify time delay at second point on timing curve for inverse time relays.
f) Plot operating characteristic.

6) ANSI No. 46, Current Balance Relay:

a) Determine pickup of unit.
b) Determine percent slope.
c) Determine time delay.

7) ANSI No. 46N, Negative Sequence Current Relay:

a) Determine negative sequence alarm level.
b) Determine negative sequence minimum trip level.
c) Determine maximum time delay.
d) Verify two points on I2T curve.

8) ANSI No. 47, Phase Sequence or Phase Balance Voltage Relay:

a) Determine positive sequence voltage to close N.O. contact.
b) Determine positive sequence voltage to open N.C. contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close N.O. contact with sudden application of 120 percent of pickup.
e) Determine time delay to close N.C. contact on removal of voltage when previously set to rated system voltage.

9) ANSI No. 50, Instantaneous Overcurrent Relay:

a) Determine pickup.
b) Determine dropout.
c) Determine time delay.

10) ANSI No. 51, Time Overcurrent:

a) Determine minimum pickup.
b) Determine time delay at two points on time current curve.

11) ANSI No. 64, Ground Detector Relay:

a) Determine maximum impedance to ground causing relay pickup.

12) ANSI No. 67, Directional Overcurrent Relay:

a) Determine directional unit minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Plot operating characteristics.
e) Determine overcurrent unit pickup.
f) Determine overcurrent unit time delay at two points on time current curve.

13) ANSI No. 87, Differential Relay:

a) Determine operating unit pickup.
b) Determine operation of restraint unit.
c) Determine slope.
d) Determine harmonic restraint.
e) Determine instantaneous pickup.
f) Plot operating characteristics for restraint.

d. Control Verification:

1) Functional Tests:

a) Check operation of active digital inputs.
b) Check output contacts or SCRs, preferably by operating controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) On completion of testing, reset minimum/maximum recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

I. Ground-Fault Protection Field Tests: Evaluate interconnected system in accordance with switchgear manufacturer's published instructions.

1. Determine proper location of sensors around bus of circuit to be protected. This determination may be done visually, with knowledge of which bus is involved.
2. Verify grounding points of system to determine that ground paths do not exist that would bypass sensors. Use high-voltage testers and resistance bridges.
3. Test installed system for correct response by application of full-scale current into equipment to duplicate ground-fault condition, or by equivalent means such as by simulated fault current generated by the following:

a. A coil around sensors.
b. A separate test winding in sensors.

4. Record test results on test form provided with instructions provided by manufacturer.

J. DC System VRLA Batteries Field Test:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify that equipment nameplate data complies with the Contract Documents.
e. Inspect physical and mechanical condition.
f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify that units are clean.
h. Inspect spill containment installation.
i. Verify application of oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.
b. Verify charger functions and verify that alarms comply with system manufacturer's published instructions.
c. Measure negative post temperature. This temperature must comply with manufacturer's published data or IEEE 1188.
d. Measure charger float and equalizing voltage levels. These levels must be in accordance with battery manufacturer's published data.
e. Measure monoblock/cell voltage and total battery voltage with charger energized and in

float mode of operation. Monoblock/cell voltages must be in accordance with manufacturer's published data.

f. Measure intercell connection resistances.

g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) may not vary by more than 25 percent between identical cells that are in fully charged state. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) may not vary by more than 25 percent between identical monoblocks/cells in fully charged state.

h. Perform load test in accordance with manufacturer's published data or IEEE 1188. Replace units that fail to pass test.

i. Measure battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground must be equal in magnitude to voltage measured from negative-to-ground.

K. DC System Vented NiCd Batteries Field Test:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.

b. Verify that battery area ventilation system is operable.

c. Verify existence of suitable eyewash equipment.

d. Verify that equipment nameplate data complies with the Contract Documents.

e. Inspect physical and mechanical condition.

f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.

g. Verify electrolyte level. Measure pilot-cell electrolyte temperature, and correct as recommended by manufacturer's maintenance procedures to bring temperature and electrolyte level to within normal limits.

h. Verify that units are clean.

i. Inspect spill containment installation.

j. Verify application of oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.

b. Verify charger functions and verify that alarms comply with system manufacturer's published instructions.

c. Measure cell voltage and total battery voltage with charger energized and in float mode of operation. Cell voltages must be within 0.05 V of each other or in accordance with manufacturer's published data.

d. Measure intercell connection resistances.

e. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) may not vary by more than 25 percent between identical cells that are in fully charged state.

f. Perform load test in accordance with manufacturer's published data or IEEE 1106. Replace units that fail to pass test.

g. Measure battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground must be equal in magnitude to voltage measured from negative-to-ground.

L. System Function Tests: Perform system function tests after other field quality-control tests have been completed and components have passed specified tests. Verify correct interaction of sensing, processing, and action devices.

1. Develop test parameters and perform tests for purpose of evaluating performance of integral

components and their functioning as complete unit within design requirements and manufacturer's published data.
2. Verify correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify correct operation of sensing devices, alarms, and indicating devices.

M. Nonconforming Work:

1. Switchgear components will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

N. Collect, assemble, and submit test and inspection reports. Record as-left set points of adjustable devices.

O. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.6 MAINTENANCE

A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, and if requested by Owner, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at switchgear outgoing sections. Use voltmeters with calibration traceable to NIST standards and with chart speed of not less than **1 inch (25 mm)** per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust switchgear taps.
b. Prepare published request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
4. Report:

a. Prepare published report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of electrical power connections of switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare certified report that identifies testing technician and equipment used and that lists results as follows:

a. Description of equipment to be tested.
b. Discrepancies.
c. Temperature difference between area of concern and reference area.

d. Probable cause of temperature difference.
e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations in NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
5. [**Follow-up Infrared Scanning: Perform additional follow-up infrared scan of switches 11 months after date of Substantial Completion.**]

C. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

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Task	Specification	Specification Description
26 12 19 00	26 12 13 00	Liquid-Filled, Medium-Voltage Transformers
26 12 19 00	26 22 13 00	Low-Voltage Distribution Transformers

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SECTION 26 13 29 00 - MEDIUM-VOLTAGE COMPARTMENTALIZED SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes dead-front, remotely controlled insulated vacuum load and fault interrupting switchgear.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

B. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted switchgear and to provide a fully insulated connection. Also called an "elbow connector."

C. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or non-load break, separable insulated connector (bushing).

D. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

E. Fault Interrupter: A self-controlled mechanical switching device capable of making, carrying, and automatically interrupting an alternating current. It includes an assembly of control elements to detect overcurrents and control the fault interrupter. A fault interrupter always consists of a switching device, a control unit, and sensors for current and/or voltage sensing.

F. Hotstick: An insulated stick, usually made of fiberglass, that is used to work energized overhead conductors and operate electrical equipment that is overhead, underground, and compartmentalized.

G. NETA ATS: InterNational Electrical Testing Association, Acceptance Testing Specification.

H. Way: A three-phase or single-phase circuit connection to the bus that may contain combinations of switches and protective devices or may be a solid bus.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For pad-mounted switchgear.

1. Include a tabulation of installed devices with features and ratings.
2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations must show major components and features, and they will mimic bus diagram.
3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended work space, and locations of penetrations for grounding and conduits. Show location of anchor bolts[**and leveling channels**].
4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
5. Include list of materials.
6. Locate accessory and spare equipment storage.
7. Include single-line diagram.
8. Include control power wiring diagrams.
9. Include battery, charger, and transfer switch ratings.
10. Include copy of nameplate.
11. Switchgear Ratings:

    a. Voltage.
    b. Continuous current.
    c. Short-circuit rating.
    d. BIL.

12. Design Calculations: Signed and sealed by a qualified professional structural engineer. Calculate requirements for selecting seismic restraints.
13. Relay settings.
14. Interface data with monitoring or control network.
15. Wiring Diagrams: For each switchgear assembly, include the following:

    a. Power, signal, and control wiring.
    b. Three-line diagrams of current and future secondary circuits, showing device terminal numbers and internal diagrams.
    c. Schematic control diagrams.
    d. Diagrams showing connections of component devices and equipment.
    e. Schematic diagrams showing connections to remote devices[**including SCADA remote terminal unit**].

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For pad-mounted switchgear.

1. Switch ratings as listed in IEEE C37.74.
2. Interrupter ratings as listed in IEEE C37.60.
3. Coating system compliance with the IEEE standard listed in "Switchgear Enclosure" Article.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 WARRANTY

A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace the switchgear control system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for VRLA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

2. Warranted Cycle Life for Premium VRLA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 40 discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 1.5 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 750 discharge cycles.

PART 2 - PRODUCTS

2.1 MEDIUM-VOLTAGE COMPARTMENTALIZED SWITCHGEAR

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**S&C Electric Company**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**S&C Electric Company**]
4. <**Insert manufacturer's name**>

2.2 SYSTEM DESCRIPTION

A. Manufactured Unit: Pad-mounted switchgear, designed for application in [**solidly grounded neutral**][**ungrounded**][**impedance-grounded**] underground distribution systems.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory, and marked for intended location and application.

C. Comply with IEEE C2.

D. Comply with IEEE C37.74.

2.3 RATINGS

A. Switchgear is applied to a nominal [**4.16**][**13.2**][**13.8**][**23**][**24.94**][**34.5**]<**Insert voltage**> kV (L-L) medium-voltage electrical power system. Minimum ratings of the switchgear must be as follows:

1. Rated Maximum Voltage and Rated BIL: [**15.5 kV and 95 kV BIL**][**27 kV and 125 kV BIL**][**38 kV and 150 kV BIL**]<**Insert voltage**>.
2. Continuous and Load Interrupting Current: 600 A.
3. Short-Time and Short-Circuit Interrupting Current: [**12.5 kA SYM RMS**][**16 kA SYM RMS**][**20 kA SYM RMS**][**25 kA SYM RMS**].

2.4 SWITCHGEAR ENCLOSURE

A. Weatherproof enclosure with an integral skid mounting frame, designed for mounting on a concrete pad, suitable to allow skidding or rolling of the switchgear in any direction, and with provision for anchoring the frame to the pad.

B. Enclosure Integrity: Comply with IEEE C57.12.28 for compartmentalized enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.

1. Each vertical section must have the following features:

a. Structural design and anchorage adequate to resist loads imposed by [**125 mph (200 km/h)**]<**Insert wind speed**> wind.
b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of each section above expected dew point.
c. Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
d. Weatherproof ground-fault circuit interrupter duplex receptacles.
e. Power for heaters and receptacles must be provided [**by control power transformer**][**as indicated**].
f. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.

C. Corrosion Protection:

1. Enclosure coating system must be factory applied, meeting the requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], in manufacturer's standard color [**green**]<**Insert color**>.
2. Fabricate the support frame, enclosure base, and the enclosure from stainless steel, ASTM A167,

Type 304 or 304L. Enclosure coating system must be factory applied, meeting the requirements of [**IEEE C57.12.28**][**IEEE C57.12.29**], standard color [**green**]<**Insert color**>.

2.5 SWITCHGEAR CONSTRUCTION

A. Dead-front, front and rear access switchgear.

B. Each disconnect switch in switched ways must be in a sealed, dielectric filled [**stainless**]steel tank, factory-filled with [**SF6 gas**][**mineral oil**][**or**][**less-flammable, high-firepoint fluid**].

1. SF6 Gas: Comply with ASTM D2472. Provide enclosure with pressure gauge and self-sealing fill valve.
2. Mineral Oil: Comply with ASTM D3487, Type II, and tested for compliance with ASTM D117. Provide enclosure with level gauge to monitor the dielectric level; automatic pressure relief valve; and fill, drain, and sampling valves.
3. Less-flammable, high-firepoint fluid must comply with ASTM D6871 and IEC 61099. The temperature rating of the fluid must be satisfactory for ambient air temperatures of **minus 22 and plus 104 deg F (minus 30 and plus 40 deg C)**. Provide enclosure with level gage to monitor the dielectric level; automatic pressure relief valve; and fill, drain, and sampling valves.

C. Construct switchgear assembly with switched ways that have front-accessible terminations for cables entering from below and with manual operating provisions with a lineman's hotstick.

D. Trapped Key Interlocks: Kirk key interlock system using a dowel pin design having no openings. Brass housing and 316 stainless steel key and lock bolts.

E. Viewing Windows: For each switch, located adjacent to manual operating devices, and positioned to show switch contact position.

F. Grounding: Provision to make grounding cable and wire connections at each way.

2.6 SWITCHED WAYS

A. Source Switch Ways: Non-fused, hotstick operated, ganged vacuum load interrupter switches[**, in series with a visible-break disconnect switch**].

1. Rated Continuous Current and Load Switching Current: 600 A.
2. Vacuum Load Interrupter:

    a. With 24 V(dc) motor operators to open or close the load interrupter.
    b. Trip-free switch mechanism. Closing the switch must be independent of the speed of the operating handle.

3. Visible-Break Disconnect Switch: [**Three positions, with open, closed, and ground positions**][**Two positions, with open and closed positions**]. The switch must be mechanically interlocked so that the vacuum interrupter opens and closes first.

    a. Switch position indicator, clearly labeled.
    b. Padlocking and tagging provisions.

B. Fault Interrupting Switched Ways: Non-fused, hotstick-operated, ganged vacuum fault interrupter switches[**, in series with a visible-break disconnect**]. With internally mounted current transformers and electronic overcurrent sensing for [**single-phase or**]three-phase ganged tripping of the interrupter.

Comply with IEEE C37.60.

1. Rated Continuous Current and Load Switching Current: 600 A.
2. Vacuum Fault Interrupter:

    a. Operated by a motor-charged stored energy mechanism, with provision to manually charge the mechanism. Charging motors must operate at 24 V(ac).
    b. Auxiliary Switches: Provide two auxiliary switches, each with field-selectable NC or NO switch position, for connection of remote indication of the position of the switched way. The switches must be rated at 15 A, 120 V(ac), and 1 A, 120 V(dc).
    c. Trip-free switch mechanism when manually operated. Closing the switch must be independent of the speed of the operating handle.
    d. Single operating handle and a clearly labeled switch position indicator; open, closed, tripped.
    e. Operations Counters: Mechanical type, linked to the operating handle of each switched way.
    f. Padlocking and tagging provisions.

3. Visible-Break Disconnect Switch: [**Three positions, with open, closed, and ground positions**][**Two positions, with open and closed positions**]. The switch must be mechanically interlocked so that the switch cannot be operated unless the vacuum fault interrupter is open.

    a. Switch position indicator, clearly labeled.
    b. Padlocking and tagging provisions.

C. Controls:

1. Motor Actuators: "Open," "close," and "stop" push buttons.
2. Switch Status LEDs: "Open" and "closed" lights. Show status of disconnect switch using its auxiliary contact.
3. Motor Actuator Process LEDs: "Opening" and "closing" lights indicating that the selected motor is operating the switch.
4. Power Switch: "On" and "off" toggle switch and circuit protector, to disconnect the dc supply to its motor and provide overload and short-circuit protection.
5. 120 V(ac) LED to display battery system power level.
6. Battery voltage meter to show battery condition.
7. Local and Remote Selector: In the "local" position remote operation of the switches is disabled and is possible only under the control of switchgear-mounted push buttons.

D. Overcurrent[**and Control**] Relays: Field-adjustable microprocessor electronic relays in each phase at indicated locations. Provide for current adjustment from 0 to 600 A.

1. Device Functions: [**51/50, 51N/50N, or 51G/50G in accordance with IEEE C37.2**]<**Insert values**>.

2.7 POWER SUPPLY

A. The power supply for instrumentation, communications, and switch operations must be for connection to two 120 V(ac) power sources, controlled by an automatic transfer switch to connect to the alternate supply when the primary supply has failed.

B. The power supply for instrumentation, communications, and switch operations must be from a potential transformer installed as part of the switchgear.

C. Control Power Supply: Dedicated [**48 V(dc)**][**120 V(dc)**][**240 V(dc)**] battery system.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**C&D Technologies, Inc.**]
   b. [**EnerSys**]
   c. [**Trojan Battery Company**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**C&D Technologies, Inc.**]
   b. [**EnerSys**]
   c. [**Trojan Battery Company**]
   d. <**Insert manufacturer's name**>

3. System Requirements: Battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at **77 deg F (25 deg C)** with electrolyte at normal level and minimum ambient temperature of **55 deg F (13 deg C)**. Cycle battery before shipment to guarantee rated capacity on installation. Arrange to operate ungrounded. Battery system capacity must be as recommended by switchgear manufacturer to operate the circuit breakers for intended duty.
4. Battery:

   a. [**Standard VRLA**][**Premium VRLA**]<**Insert type**> batteries, with system disconnect and overcurrent protective device.
   b. Rack: [**Two**]<**Insert number**>-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.[**Rate battery rack, cell supports, and anchorage for seismic requirements.**]
   c. Accessories:

      1) Set of cell numerals.
      2) Monitoring system.

   d. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.

      1) DC ammeter.
      2) DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
      3) Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by NO push-button contact.
      4) Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
      5) Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.

6) AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. Automatic charger operation must resume after loss of ac power supply for any interval.
7) Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. The device must regulate charging current but must not disconnect charger from either battery or ac supply.
8) Charger's Audible Noise: Less than 26 dB.

5. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
6. Control Wiring: Factory installed, complete with bundling, lacing, and protection.

    a. Conductors across Hinges and for Interconnections between Shipping Units: Flexible conductors for No. 8 AWG and smaller.
    b. Conductors: Sized in accordance with NFPA 70 for duty required.

7. An automatic transfer switch to connect the alternate power supply when the primary power supply has failed.

2.8 AUTOMATIC SOURCE TRANSFER CONTROLS

A. An automatic switch control system must execute manual, automatic source-transfer, and SCADA operation of the source and fault interrupting switch ways. The source-transfer controls must open an incoming switch way where voltage is lost and close the other incoming switch way if voltage is present. The controls must include an overcurrent lockout that prevents the closing of a switch way into a system fault.

B. The automatic switch control system must execute remote commands received from a SCADA master station and transmit switchgear operation information to a SCADA master station using DNP3 communications protocol. Execution of remote commands must include enabling of the source-transfer controls and transfer of switch ways to "close," "open," and "ground" positions. Transmission of switchgear information must include switch way positions and DC supply system status. Additional switchgear information that must be transmitted follows:

    1. Voltage.
    2. Current in load ways.
    3. <**Insert text**>.

C. The control must have communication port provisions for connection to a multi-mode serial fiber link.

2.9 CONTROL NETWORK

A. Compliance with ASHRAE 135: Controllers must support serial MS/TP and Ethernet IP communications and must be able to communicate directly via TIA-485 serial networks and Ethernet 10Base-T networks as a native device.

B. Support DNP3 protocol remote control commands received from the SCADA master stations that control switch operations. Comply with the requirements of IEEE 1815.

2.10 BUSHINGS

A. Separable insulated connectors must be used to connect primary cable. Comply with requirements in Section 260513 "Medium-Voltage Cables."

1. Bushings: One-piece, 600 A, BIL ratings the same as the connectors. Comply with IEEE 386.
2. Supply a standoff bracket or parking stand for each bushing, mounted horizontally adjacent to each bushing.

2.11 SURGE ARRESTERS

A. Distribution class; metal-oxide-varistor type, fully shielded, separable elbow type, suitable for plugging into the inserts. Comply with IEEE C62.11 and IEEE 386.

1. Nominal System Line-to-Line Voltage: <**Insert number**> kV RMS.
2. Maximum Continuous Operating Voltage: <**Insert number**> kV RMS.
3. Duty-Cycle Voltage: <**Insert number**> kV RMS.

2.12 WARNING LABELS AND SIGNS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labels and signs.

1. High-Voltage Warning Label: Self-adhesive labels on the outside of the high-voltage compartment door(s). Legend must be "DANGER HIGH VOLTAGE" printed in two lines of minimum **2 inch (50 mm)** high letters. The word "DANGER" must be in white letters on a red background and the words "HIGH VOLTAGE" must be in black letters on a white background.
2. Arc-Flash Warning Label: Self-adhesive labels on the outside of the high-voltage compartment door(s), warning of potential electrical arc-flash hazards and appropriate personal protective equipment required.

2.13 SOURCE QUALITY CONTROL

A. Factory Tests: Comply with requirements in IEEE C37.60 and IEEE C37.74 for testing procedures.

1. Circuit Resistance Test: Verify that switchgear contacts have been properly aligned and current transfer points have been properly assembled.
2. Power-frequency dry withstand voltage test.
3. Dielectric withstand test; one-minute dry power-frequency.
4. Calibrate overcurrent devices for conformance to published time-current characteristic curves.
5. Sealed Tank Leak Test:

a. Comply with IEC 62271-1 for test procedure for switchgear using SF6.
b. The test procedure for vacuum switchgear must be as follows:

1) Each vacuum tube must be identified by its serial number. Its vacuum pressure level must be tested by the manufacturer of the vacuum interrupter. Document the test results.
2) After assembly of the switchgear way, test the vacuum pressure level of the vacuum tubes by the routine dielectric test across the open contacts. The test voltage must be stated by the manufacturer. The dielectric test must be carried out after the mechanical routine test.

6. Operating tests must verify the following:

    a. Switch position indicators and contacts are in the correct position for both the open and closed positions.
    b. Insulating medium quantity indicator (if provided) is functioning properly.
    c. Circuit configuration is shown correctly.
    d. Mechanical interlocks are in place and operative.
    e. Position and polarity of current transformers meets requirements.
    f. Control, secondary wiring, and accessory devices are connected correctly.
    g. Devices and relays actually operate as intended. Circuits for which operation is not feasible must be checked for continuity.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.

1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and Shop Drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle switchgear, in accordance with manufacturer's recommendations; avoid damage to the enclosure, termination compartments, base, frame, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
3. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
4. Do not damage structure when handling switchgear.

C. Storage:

1. Switchgear may be stored outdoors. If possible, store switchgear at final installation locations on concrete pads. If dry concrete surfaces are not available, use pallets of adequate strength to protect switchgear from direct contact with the ground. Ensure switchgear is level.
2. Protect switchgear from physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
3. Store switchgear with compartment doors closed.

D. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders have to cross section barriers to reach load or line lugs.

E. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.

F. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be [**5 ohms**]<**Insert value**> at switchgear location.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SWITCHGEAR INSTALLATION

A. Equipment Mounting:

1. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install level and plumb, tilting less than 1.5 degrees when energized.

C. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's instructions and NFPA 70.

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's instructions and IEEE C2.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than **30 inch (765 mm)** below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.
2. Fence and equipment connections must not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding **10 ft. (3 m)**. Bond each gate section to the fence post using **1/8 by 1 inch (3 by 25 mm)** [**tinned**]flexible braided copper strap and clamps.
3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
4. Terminate grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure.
5. Complete the switchgear grounding and surge protector connections prior to making other electrical connections.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and

Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within the switchgear enclosure. Arrange conductors such that there is not excessive strain on the connections that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of switchgear in accordance with Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. General Field Testing Requirements:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" chapter.
2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
3. After installing switchgear but before primary is energized, verify that grounding system at the switchgear is tested at the specified value or less.
4. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.

C. Medium-Voltage Switchgear Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that current and voltage transformer ratios correspond to Drawings.
b. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
c. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
2) Make key exchange with devices operated in off-normal positions.

d. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of

connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit breaker ratings match Drawings.

2. Electrical Tests:

a. Inspect bolted electrical connections using a low-resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.

c. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

d. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

1) Minimum insulation-resistance values of control wiring must not be less than 2 megohms.

e. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

f. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

g. Perform system function tests in accordance with "System Function Tests" Article.
h. Verify operation of space heaters.
i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

D. Medium-Voltage Vacuum Interrupter Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, grounding, and required clearances.
    c. Verify that maintenance devices such as special tools and gages specified by the manufacturer are available for servicing and operating the breaker.
    d. Verify the unit is clean.
    e. Perform mechanical operation tests on operating mechanism in accordance with manufacturer's published data.
    f. Measure critical distances on operating mechanism as recommended by the manufacturer. Critical distances of the operating mechanism must be in accordance with manufacturer's published data.
    g. Verify cell fit and element alignment.
    h. Verify racking mechanism operation.
    i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    k. Perform time-travel analysis. Travel and velocity values must be in accordance with manufacturer's published data.
    l. Record as-found and as-left operation counter reading. Operation counter must advance one digit per close-open cycle.

2. Electrical Tests:

    a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.
    b. Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values must not exceed the high levels of the normal range in accordance with manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    c. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the trip and close coils must comply with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
    d. Verify correct operation of auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate in accordance with manufacturer's published data.
    e. Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.
    f. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values must comply with manufacturer's published data.
    g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time

of voltage application during the vacuum bottle integrity test, the specimen is considered to have passed the test.

h. Perform a dielectric-withstand-voltage test in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the specimen is considered to have passed the test.

E. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean the front panel and remove foreign material from the case.
e. Check tightness of connections.
f. Verify that the frame is grounded in accordance with manufacturer's instructions.
g. Set the relay in accordance with results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to the grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
c. Functional Operation: Check functional operation of each element used in the protection scheme.
d. Control Verification:

1) Functional Tests:

a) Check operation of active digital inputs.
b) Check output contacts or silicone-controlled rectifiers, preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

F. Ground Resistance Test:

1. Visual and Mechanical Inspection:

a. Verify ground system complies with the Contract Documents and NFPA 70 "Grounding and Bonding" Article.
b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections must be free of corrosion.
c. Inspect bolted electrical connections using a calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of

manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

d. Inspect anchorage.

2. Electrical Tests:

a. Perform fall-of-potential or alternative test in accordance with IEEE 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground must be no more than [**5 ohms**][**maximum ground resistance value specified in the "Examination" Article**].

b. Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with Contract Documents.

c. Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

d. Inspect physical and mechanical condition.

e. Inspect anchorage.

G. Nonconforming Work:

1. Switchgear will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

H. Prepare test and inspection reports.

3.6 SYSTEM FUNCTION TESTS

A. System function tests must prove the correct interaction of sensing, processing, and action devices. Perform system function tests after "Field Quality Control" tests have been completed and components have passed specified tests.

1. Develop test parameters and perform tests for evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

3.7 MAINTENANCE

A. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove necessary covers prior to the inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at **86 deg F (30 deg C)**.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the results as follows:

a. Description of equipment to be tested.
b. Discrepancies.
c. Temperature difference between the area of concern and the reference area.
d. Probable cause of temperature difference.
e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of the deficient area.

4. Act on inspection results in accordance with the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 26 13 29 00

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Task	Specification	Specification Description
26 13 29 00	26 11 16 11	Secondary Unit Substations with Switchgear Secondary
26 18 36 00	26 11 16 11	Secondary Unit Substations with Switchgear Secondary
26 19 18 00	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 19 80 60	26 05 00 00	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 21 13 00	26 05 13 00	Medium-Voltage Cables
26 21 13 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables

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SECTION 26 21 16 00 - PARALLELING LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multiple-generator paralleling monitoring and control system.
2. Single-generator paralleling monitoring and control system.
3. Metal-enclosed, circuit-breaker switchgear (600 V and less).

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. <**Insert products installed, but not furnished**>.

D. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
4. Section 260913 "Electrical Power Monitoring" for interfacing communication and metering requirements.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For {Insert system or product}. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of paralleling low-voltage switchgear.

a. Include technical data on features, performance, electrical characteristics, ratings, and

finishes for programmable logic controllers, instrumentation, control devices, monitoring devices, [**SCADA interface devices,**][**Ethernet interface,**] and display components.

b. Include rated capacities, operating characteristics, furnished specialties, factory settings, and accessories for individual circuit breakers.

c. Include time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings:

1. For each type of paralleling low-voltage switchgear.

a. Include dimensioned plans, elevations, sections, details, shipping sections, weights of assembled sections, and required clearances and service space around equipment.

b. Include tabulation of installed devices with features and ratings.

c. Include enclosure types and details.

d. Detail locations for anchor bolts[**and leveling channels**].

e. Show bus configuration with current rating, size, and number of conductors in bus run, including phase, neutral, and ground conductors of main and branch buses.

f. Indicate short-time and short-circuit current rating of switchgear assembly.

g. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

h. Detail nameplate legends.

i. Include mimic-bus diagram.

j. Include three-line power wiring diagrams for paralleling low-voltage switchgear, generators, and related equipment showing device terminal numbers.

k. Include point-to-point schematic control, monitoring, and alarm wiring diagrams showing internal component terminal numbers.

l. Include point-to point schematic control, monitoring, and alarm wiring diagrams for external components indicating terminal numbers for the following:

1) Engine generators.
2) Transfer switches.
3) Other load-control devices.
4) Elevator controller in elevator bank.
5) DDC system for HVAC controller.
6) SCADA remote terminal unit.

2. Sequence of Operation: Description of sequence of operation for paralleling controls in automatic, manual, system test, and peak-shaving modes.

a. Include the following in description of automatic-mode sequence of operation:

1) Programmed sequence of initial generator starting and connection of generators to isolated paralleling bus, including description of how proposed design complies with requirements for redundancy.
2) Programmed sequence of transferring loads to isolated paralleling bus based on operator-adjustable preset priorities and preset loads. Include initial load settings.
3) Programmed sequence of starting and stopping generators based on actual real-time measured loads.
4) Programmed sequence of sending load-shed signal to transfer switches[**, and to other devices**] when generator frequency does not return to normal frequency within adjustable time period.
5) Programmed sequence of stopping generators based on no transfer switch or other device sending start signal.

b. Include the following in description of system testing mode sequence of operation:

1) Load.
2) No load.

c. Include in description, peak-shaving-mode sequence of operation.
d. Include in description, manual-mode sequence of operation showing that manual mode fulfills requirement to permit operator at paralleling low-voltage switchgear to accomplish automatic, system test, and peak-shaving functions.
e. Paralleling Low-Voltage Switchgear Redundancy: Identify single points of failure.

C. Samples:

1. Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

D. Delegated Design Submittal: For seismic restraints for switchgear and wind-loading for outdoor enclosures, include analysis data signed and sealed by qualified structural professional engineer responsible for their preparation.

E. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Record Documentation: Include updated mimic bus diagram reflecting field changes after final switchgear load connections have been made, for record.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner the following spare parts for repairing paralleling switchgear that are packaged with protective covering for storage on-site and identified with labels describing contents:

1. Control Power Fuses: [**Six**]<**Insert number**> of each type and rating used. Include spares for the following:

a. Potential transformers.
b. Control power circuits.

2. Indicating Lights: [**Six**]<**Insert number**> of each type installed.
3. Draw-out Circuit Breakers: One of each type and rating used for circuit breaker in paralleling low-voltage switchgear.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchgear, packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Racking handle to move circuit breaker manually between connected and disconnected positions.
2. Tools for circuit-breaker and switchgear tests, inspections, maintenance, and operation.
3. Portable test set for testing functions of circuit-breaker, solid-state trip devices without removal from switchgear.
4. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
5. Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
6. Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of draw-out circuit breaker installed.
7. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
8. Storage for Manual: Rack or holder, near operating instructions, for copy of maintenance manual.

C. Consumable Items:

1. After completion of field quality control, startup, commissioning, adjusting, and closeout activities, replace air filters and refill fluid reservoirs.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver paralleling low-voltage switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store paralleling low-voltage switchgear indoors in clean dry space with uniform temperature to prevent condensation.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed paralleling switchgear perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of paralleling switchgear perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS[**TO BE MODIFIED**][**TO BE REMOVED AND RE-INSTALLED**]

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Multiple-generator paralleling monitoring and control panel in paralleling low-voltage switchgear must monitor and control the following standby power system components:

1. Paralleling low-voltage switchgear.
2. Single-generator monitoring and control system.
3. Single-generator paralleling monitoring and control systems that are [**part of paralleling low-voltage switchgear**][**located at individual engine generator**].
4. Engine generators.
5. Transfer switches.
6. Circuit breakers downstream of transfer switches.
7. Other load-control devices.
8. Distribution circuit breakers in paralleling low-voltage switchgear.

C. Redundant Standby Power System:

1. Single generator with associated single-generator paralleling monitoring and control system.
2. Black-start controller with no single point of failure.
3. Black-start controller with backup control in multiple-generator paralleling monitoring and control system.
4. Multiple-generator paralleling monitoring and control system must automatically be performed by backup system without degradation in the event that primary system fails to function (such as component failure or off-line maintenance).
5. Multiple-generator paralleling monitoring and control system must automatically be performed by backup system without degradation in the event that primary system fails to function (such as component failure or off-line maintenance), except for the following manually operated functions:

    a. Load management.
    b. Peak shaving.
    c. <**Insert exceptions**>.

D. Sequence of Operation for Normal Conditions:

1. Paralleling low-voltage switchgear, including controlled generators[**, controlled circuit breakers,**][**, other controlled devices,**] and transfer switches, must be in automatic position and

ready to operate on loss of power or other designated initiation conditions.

2. Single-generator monitoring and control system has not received "start" signal from the following:

    a. Transfer switch.
    b. Multiple-generator paralleling monitoring and control system.
    c. <**Insert device**>.

E. Sequence of Operation for Loss of Normal Power Conditions:

1. Single-generator monitoring and control system must receive start signal from redundant system.

    a. Start signal may come from transfer switch[**or other device**] directly wired to start engine generator.
    b. Start signal may come from multiple-generator paralleling monitoring and control system that monitors loss of normal source availability from one or more transfer switches[**or other device**].

2. On receiving start signal, single-generator monitoring and control system must start engine generators and achieve rated voltage and frequency.
3. If engine generator fails to start, after expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
4. Transfer Inhibit Control: Multiple-generator paralleling monitoring and control system receives loss of normal source availability signal from transfer switch(es)[**or other device**] and sends transfer inhibit signals.

    a. Transfer switch(es) serving emergency loads may not be sent transfer-inhibit signal.
    b. Transfer switch(es) serving other than emergency loads that must transfer within required time must have transfer-inhibit signal end at such time as will permit transfer switch to operate within required time.
    c. Transfer switch(es) serving other than emergency loads that are not required to transfer within required time must be sent transfer-inhibit signal.
    d. Transfer switch(es) serving loads that are to be disconnected after detecting loss of normal source availability must signal associated circuit breakers and other load devices to de-energize these predetermined loads.
    e. Transfer switch(es) serving HVAC loads that need to operate at lower load by modifying HVAC sequence of operation after detecting loss of normal source availability must signal DDC system for HVAC to change to HVAC load-shed sequence of operation for associated equipment.
    f. Transfer switch(es) serving elevator loads after detecting loss of normal source availability must signal associated elevator controllers that elevators are connected to generator power and must initiate sequence of operation in elevator control system to protect elevators and to reduce elevator load demand.
    g. Distribution circuit breakers in paralleling low-voltage switchgear, which are indicated in priority-load schedule to transfer load by opening and closing circuit breaker, receive inhibit closing signal.

5. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus.

    a. Comply with requirements in applicable engine generator Section for selection of first engine generator to connect to isolated paralleling bus.
    b. Redundant System: Multiple-generator paralleling monitoring and control system selects first engine generator to connect to isolated paralleling bus.

6. Single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to isolated paralleling bus. On closure to isolated paralleling bus, engine generator assumes its proportional share of total load.
7. Failure of Engine Generator to Synchronize: If engine generator fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.

F. Priority Controller Sequence of Operation:

1. Programming from Human-Machine Interface for Priority Controller:

   a. Set priority blocks of load that indicate priority number and scheduled size of load from Priority-Load Schedule. Set generator blocks of capacity that indicate individual engine generators and their capacity.
   b. Signal to transfer loads to engine generator source may be accomplished by one of the following:

      1) Signaling to transfer-inhibit enable transfer switch associated with priority load to transfer load.
      2) Signaling load-add relay at transfer switch to transfer priority load.
      3) Closing distribution-feeder circuit breaker associated with priority load.
      4) Enabling another device.

2. When generator has transferred Priority 1 emergency load, send signal to transfer loads that must be transferred within specific time in accordance with Priority-Load Schedule.
3. When generator capacity is adequate to support next priority load, send signal to transfer next priority load to generator source until priority loads have been transferred.

G. Overload Sequence of Operation:

1. Signal to shed loads from generator source may be accomplished by one of the following:

   a. Signaling load-shed relay in transfer switch associated with priority load.
   b. Opening distribution-feeder circuit breaker associated with priority load.
   c. Disabling another device.

2. Overload sequence of operation sends signal to shed lowest connected load priority when isolated paralleling bus frequency does not return to normal frequency within its adjustable time period.
3. If isolated paralleling bus does not return to normal frequency after shedding lowest connected priority load within adjustable time period, additional load continues to be shed by signaling to load shed in reverse priority until isolated paralleling bus returns to normal frequency.
4. Loads shed can be reconnected to isolated paralleling bus only by manual reset at human-machine interface.

H. Load-Demand Sequence of Operation:

1. With load-demand sequence of operation activated, controller continuously monitors total isolated paralleling bus load.
2. If isolated paralleling bus load is below preset limits and after preset time delay, demand controller shuts down engine generators in predetermined order until minimum number of sets are operating. Set preset limits, predetermined order, and preset time delay, as well as choose manual operation, from human-machine interface.
3. On sensing available isolated paralleling bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.

I. Individual Transfer Switch Return to Normal Condition Sequence of Operation: Enable individual transfer switches to return to normal power when normal power is available at transfer switch.

J. Feeder Circuit Breakers in Paralleling Low-Voltage Switchgear Return to Normal Condition Sequence of Operation: When normal power is available at transfer switches served by feeder circuit breaker, open circuit breaker.

K. Individual Circuit Breaker or Other Load Device for Loads Controlled Downstream from Transfer Switch Sequence of Operation: Return circuit breaker or other load device to closed position when transfer switch serving circuit breaker has returned to normal power.

L. Return to Normal Condition Sequence of Operation:

1. Process starts on removal of start signals from system.
2. When no load remains on isolated paralleling bus, generator breakers open, go through cool-down period, and shut down.
3. If start signal is received during cool-down period, one engine generator is reconnected to isolated paralleling bus, and system operation follows that of "loss of normal power."

M. System Test Sequence of Operation:

1. Configure tests to comply with NFPA 110, Level 1 testing requirements for generator. Automatically generate NFPA 110, Level 1 reports.
2. Single-generator test.
3. Multiple-generator test.
4. Start generators manually, by generator exerciser on user-defined schedule, or by remote contact from [**DDC system for HVAC**][**SCADA system**].
5. Engine generator(s) start and achieve rated voltage and frequency.
6. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
7. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus. Single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to isolated paralleling bus. On closure to isolated paralleling bus, engine generator assumes its proportional share of total load.
8. Failure of Engine Generator to Synchronize: If engine generator fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.
9. Manually select or automatically preselect whether test is load or no-load test. If test is load test, manually select or automatically preselect loads to be transferred in accordance with schedule or by adjustable time delays at transfer switches. After generators are connected to isolated paralleling bus, transfer loads by sending signal to load-add relay that is connected to input for "remote transfer to generator source" of transfer switch controller or to other devices.[**If test is load-bank test, automatically operate load-bank breaker to connect load bank for testing generators based on number and configuration of generators.**]
10. After adjustable period of time system, allow engine generators to optimize down to only required number to be online to avoid wet stacking. Set stopping and starting sequences through human-machine interface panel device and allow settings based on manual priorities or by engine run time.
11. On sensing available bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.
12. After system test is completed, transfer loads back to normal power with transfer switches. Shut down system using sequence in automatic mode.

13. If there is outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send load-shed signals to lower-priority loads until load is below generator capacity, signal engine generator that is not currently operating to start, and cancel system test.

N. Peak-Shaving Sequence of Operation:

1. Start engine generators manually through human-machine interface or by remote contact initiated from peak-shaving command from [**DDC system for HVAC**][**SCADA system**].
2. Engine generator(s) start and achieve rated voltage and frequency.
3. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
4. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus.
5. Single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to isolated paralleling bus. On closure to isolated paralleling bus, engine generator assumes its proportional share of total load.
6. Failure of Engine Generator to Synchronize: If generator set fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.
7. Through human-machine interface manually select or on closure of contact from peak-shaving command preselected loads to be automatically transferred to isolated paralleling bus. After engine generators are connected to isolated paralleling bus, transfer loads by sending signal to corresponding load-add relays that are connected to remote transfer to generator source control input at transfer switch or similar control devices. Add loads until contact closure from [**DDC system for HVAC**][**SCADA system**] opens.
8. After adjustable period of time, allow engine generators to optimize down to only required number to be online to avoid wet stacking. Set stopping and starting sequences through human-machine interface panel device and allow settings based on manual priorities or by engine run time.
9. If isolated paralleling bus load is below preset limits and after preset time delay, demand controller shuts down engine generators in predetermined order until minimum number of sets are operating. Set preset limits, predetermined order, and preset time delay, as well as choose manual operation, from human-machine interface.
10. On sensing available isolated paralleling bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.
11. After peak shaving is completed, transfer loads back to normal power. Shut down system using sequence in automatic mode.
12. If there is outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send, send load-shed signals to lower-priority loads until load is below engine generator capacity, signal generators that are not currently operating to start, and cancel system peak-shaving operation.
13. Manual Sequence of Operation: Include functions indicated for automatic mode, except that operator must be able to monitor parameters and manually perform operations.

O. Comply with NFPA 110 for the following:

1. Legally Required Standby Systems: EPSS Level 1, Type 10.
2. Optional Standby Systems: EPSS [**Level 1**][**Level 2**], [**Type 10**][**Type 60**][**Type 120**][**Manual**].

P. Comply with NFPA 99 for healthcare applications.

2.4 MULTIPLE-GENERATOR PARALLELING MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Russelectric, Inc**]
6. [**SAI Advanced Power Solutions/Switchboard Apparatus Inc.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Russelectric, Inc**]
6. [**SAI Advanced Power Solutions/Switchboard Apparatus Inc.**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain paralleling low-voltage switchgear from same manufacturer as required for [**engine generator**][**transfer switches**][**transfer switches and engine generators**].

D. Components and Devices: Factory mounted in [**metal-enclosed, paralleling low-voltage switchgear**][**separate switchboard**].

1. Paralleling Low-Voltage Switchgear Door-Mounted Control Devices: Industrial, oil-type devices.
2. Indicator Lamps: High-intensity digital display.

E. Control Power for Multiple-Generator Monitoring and Control System: Supplied from 24 V(dc) starting batteries of engine generators.

1. Isolate battery bank to prevent failure of one battery from disabling entire system.
2. Include, if necessary, separate control power battery system rated 24 V(dc) for equipment unable to accept voltage drop that occurs during engine cranking.

F. Redundant Multiple-Generator Monitoring and Control System Controller:

1. Fully equip with hot swappable programmable logic controller, power supplies, and I/O points.
2. Black-start control equipment specified in applicable engine generator Section.

G. Multiple-generator monitoring and control system auto/manual selector switch.

H. Control switch for circuit breaker that serves load bank.

I. Full-Color, Touch-Screen, Human-Machine Interface Device:

1. Minimum viewing area of [**60 sq. inch (387 sq. cm)**][**100 sq. inch (645 sq. cm)**] must be configurable in either U.S. Standard or SI (metric) units.
2. Main Menu: Include date, time, and system status messages. Configure screens so that no

screen is more than three touches from other screen.

a. Individual engine generator data must be accessed at paralleling low-voltage switchgear from [**main menu**][**main menu and single-generator paralleling monitoring and control system**].

3. One-Line Diagram: Depicting system configuration and system status by screen animation, screen colors, text messages, or pop-up indicators.

a. Conditions for Engine Generators, Buses, and Paralleling Circuit Breakers: Energized or de-energized.
b. Engine Generator Modes:

1) Auto.
2) Lockout.
3) Reset.
4) Off.
5) Cool down.
6) Test off line.
7) Test on load.

c. Engine Generator Status: Normal, warning, shutdown, or load-demand stop.
d. Paralleling Circuit-Breaker Status: Open, closed, or tripped.
e. Bus Conditions: Energized or de-energized.
f. Percent load.

4. AC metering screen for isolated paralleling bus must display the following:

a. Phase, volts, and amperes.
b. Kilowatts.
c. Kilovolt amperes.
d. Kilovolt-ampere rating.
e. Power factor.
f. Frequency.
g. Kilowatt hour.
h. Kilowatt demand.
i. Real-time trend chart for system kilowatts and volts updated on not less than one-second intervals.
j. A minimum of one historical trend chart for total system loads with intervals no shorter than five minutes and minimum duration of four hours.
k. Percent of available capacity of engine generators that are operating in parallel on bus.

5. Engine Generator Monitoring and Control Screen:

a. Control:

1) Engine generator manual start/stop control (functional only when paralleling low-voltage switchgear mounted control switch is in "Auto" position).
2) Engine generator alarm reset.
3) Manual paralleling and circuit-breaker enable/inhibit controls.
4) Engine function and timer settings.
5) System function, testing, and timer settings.
6) Engine generator optimization settings: automatically determine priority of engine generators based on engine run time and number of engine starts or manually assign engine priorities.

b. Status and Alarms:

1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
2) Engine run hours.
3) Engine status.
4) Number of generator circuit-breaker operations.
5) Replicate status and alarms from single-generator paralleling monitoring and control panel.

6. Dual, Three-Phase, Metering Screen: Graphical analog (270 electrical degree) metering representation with digital display. Display two generators at same time or one generator and isolated paralleling bus at same time. Display graphical synchroscope when one generator and isolated paralleling bus are selected.

a. True RMS, three-phase voltage, amperes, kilowatts, kilovolt amperes, kilovolt-ampere reactive, power factor, and frequency parameters.
b. Engine battery voltage display.

7. Password-Protected System Control Screen:

a. System Test Modes: Test with load/test without load/normal/retransfer time-delay override.
b. Test with Load: Starts and synchronizes engine generators on isolated paralleling bus; loads are transferred to isolated paralleling bus.
c. Test without Load: Starts and synchronizes engine generators on isolated paralleling bus but does not transfer loads to isolated paralleling bus.
d. Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

8. Password-Protected, Peak-Shaving Control Screen:

a. Peak-Shaving Modes: Manual start and transfer of loads; automatic start and transfer of loads by DDC system for HVAC peak-shaving relay closure.
b. For automatic mode, set load priorities for peak-shaving function.
c. Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

9. Load-Demand Control Screen: Monitors total load on isolated paralleling bus and controls number of engine generators running so that capacity tracks load demand.

a. Load-Demand Control: Enable/disable.
b. Set engine generator shutdown sequence.
c. Load-Demand Pickup Set Point: Adjustable from 90 to 40 percent in 5 percent increments.
d. Load-Demand Dropout Set Point: Adjustable from 20 to 70 percent in 5 percent increments.

10. Manual Load Control Screen: Allows operator to manually add or delete engine generators from paralleled system in response to system load parameters.

a. Indication of system available in kilowatts and amperes.
b. Control functions allow manual addition/removal of engine generators on system, and activation of load-shed/load-restore functions.

11. Load-Add/Load-Shed Sequence Screen: Password protected and with the following minimum functions:

a. Display sequence.
b. Assigns "load-add sequence priority" to load-control relay with designation for relay operation after set number of engine generators are online.
c. Assigns "load-shed sequence priority" to load-control relay with designation for relay operation depending on number of engine generators online.

12. Alarm Summary and Run Report Screen:

a. Lists most recent alarm conditions and status changes.
b. Lists minimum of most recent 32 alarm conditions by name and time/date; acknowledges alarm conditions with time/date.
c. For start signal, lists start time and date, stop time and date, maximum kilowatt and ampere load on system during run time, and start and stop times of individual engine generators.
d. Lists generator circuit position and status.
e. Access to trend monitored automatic transfer switches.
f. [**16-gigabyte**]<**Insert value**> hard-disk space for storing database file for multiple-generator paralleling monitoring and control panel trending and event logging. Trend and log data at resolution of one second. If hard drive is full, overwrite in first-in-first-out procedure.

1) Trend up to eight monitored points simultaneously.

13. Load Status and Control Screen: Displays status of automatic transfer switches connected to system for [**32**][**64**] transfer switches, and other controlled devices.

a. Automatic transfer switch connected to normal.
b. Automatic transfer switch connected to emergency.
c. Controlled circuit breakers downstream from automatic transfer switch device enabled or disabled.
d. Engine start indication.
e. Load-shed indication.
f. Load-add indication.
g. Inhibit to emergency source.
h. Inhibit to normal source.
i. Transfer Switch Power Metering Function: Total kilowatt, three-phase current, and three-phase voltage.
j. Automatic Transfer Switch Load Priority: Ability to change priorities of automatic transfer switches (password protected).
k. Display name, status, and priority of load block (whether on or off) and total load of that block.
l. Allow for manually adding or shedding loads.

14. Automated email messages must be transmitted when shutdowns occur and must include time and date of alarm.
15. Based on either number operations or time since last maintenance, suggest maintenance period for generator (run hours), controlled circuit breaker (number of operations), and transfer switches (number of transfers).
16. Status and Alarm Screen:

a. Visual alarm status indicator and alarm horn with silence and acknowledge push-button.
b. Status, Light Only:

1) "SYSTEM NOT IN AUTO" (red).
2) Running Status: Display engine generator number and running-status light (green).
3) Load-demand mode (green).

4) Priority Load Status: Display load number with "LOAD ADD" (green) and "LOAD SHED" (red).
5) System test (green).
6) Remote system start (red).
7) Monitoring of Transfer Switch:

a) Normal source available (green).
b) Connected to normal (green).
c) Generator source available (green).
d) Connected to generator source (green).

c. Status Light and Alarm:

1) Isolated paralleling bus under frequency (red).
2) Isolated paralleling bus over frequency (red).
3) Auxiliary power failure (red).
4) Emergency start signal power failure (red).
5) Load-Shed Level Status: Displays load number and red load-shed, status light.
6) Generator Alarm Status: Displays generator number and red "Check Generator" status light.
7) Controller malfunction (red).
8) Check station battery (red).
9) Isolated paralleling bus overload (red).
10) System not in auto (red).
11) Main tank, low fuel (amber)
12) Main tank, high fuel (amber).
13) Main tank, fuel leak (red).

J. Remote Monitoring: Replicate human-machine interface monitoring functions [**at SCADA**][**at remote computer terminal**][**via communication bus**].

K. Remote Monitoring of Status and Alarms: Replicate human-machine interface status and alarms at DDC system for HVAC via isolated contacts.

2.5 SINGLE-GENERATOR PARALLELING MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Russelectric, Inc**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]

5. [**Russelectric, Inc**]
6. <**Insert manufacturer's name**>

C. Source Limitations: Obtain paralleling low-voltage switchgear from same manufacturer as required for [**engine generator**][**transfer switches**][**transfer switches and engine generators**].

D. Components and Devices: Factory mount in single-generator section of metal-enclosed, paralleling low-voltage switchgear.

1. Paralleling low-voltage switchgear door-mounted control devices must be industrial oil-type devices. Indicator lamps must be high-intensity digital display.

E. Control Power: Supply control power from 24 V(dc) starting batteries from controlled generator. Include separate control power battery system rated 24 V(dc) for equipment unable to accept voltage drop that occurs during engine cranking.

F. Programmable Logic Controller: Factory-mounted controller, separate from multiple-generator paralleling monitoring and control system in single-generator paralleling monitoring and control module of metal-enclosed, paralleling low-voltage switchgear.

G. Single-Generator Paralleling Low-Voltage Switchgear Circuit Breaker:

1. Factory mount circuit-breaker control switch.
2. Paralleling Circuit-Breaker Monitor and Control:

a. Monitors circuit-breaker auxiliary contacts.
b. Initiates fault signal if circuit breaker fails to close within adjustable time-delay period (0.5 to 15 seconds).
c. Trips open and locks out paralleling circuit breaker on paralleling circuit breaker failure to close, until manually reset.

H. Generator Mode Selector Switch: Factory mounted in single-generator paralleling monitoring and control system module of metal-enclosed, paralleling low-voltage switchgear.

1. "Lockout/Reset" mode prevents generator from starting or immediately shuts down generator if running.
2. "Off/Cool-Down" mode stops engine after cool-down period.
3. "Auto" mode allows generator to start on receipt of remote start signal. If generator is already running and there is not start signal, then "Auto" mode allows engine to run for predetermined cool-down period before stopping.
4. "Test Off-Line" allows engine to start and run as if start signal were received, except it does not allow generator to connect to isolated paralleling bus unless start signal is received.
5. "Test Online" allows engine to start, run, and connect to isolated paralleling bus as if start signal were received.

I. Engine Generator Controller: Woodward compatible.

1. Factory mount governor (speed control and load sharing) supplied in applicable engine generator Section in single-generator monitoring and control module.
2. Loading control interface to governor system.
3. Automatic synchronizer.

J. Automatic Synchronizer:

1. Include sync mode selector switch with RUN-OFF-CHECK-PERMISSIVE positions. In RUN mode, enable active synchronization and sync-check function. In CHECK mode, perform sync-

check function. In PERMISSIVE mode, annunciate when generator and bus are synchronized but do not allow breaker closure.

a. Include discrete inputs in synchronizer to switch to each mode.

2. Bias generator speed and voltage to match paralleling isolated bus.
3. If automatic synchronizer receives permissive signal to allow closure to paralleling isolated bus and generator is within synchronizing limits, send close signal to single-generator paralleling circuit breaker.

K. Sync-switch, removable, keyed T-handle.

L. "Engine Generator Synchronized" Indication: Indicator lamp or digital-display indication of synchronization.

M. Voltage and Frequency Raise and Lower Switches: Allow plus or minus 5 percent adjustment when engine generator is operating but is not connected to isolated paralleling bus.

N. Control and Reset Push-Button: Have flashing lamp to indicate generator is locked out due to fault condition.

O. Lamp Test Push-Button: Simultaneously tests lamps on panel.

P. Control Panel Illumination: DC lamps illuminate panel when lighting from surrounding environment is unavailable.

Q. Emergency Stop Push-Button: Red mushroom-head switch maintains its position until manually reset.

R. Alarm and Status Indicating Display:

1. Status and Alarm Indications:

a. Status, Light Only (Nonlatching):

1) Generator mode selector switch not in auto (red).
2) Generator mode selector switch in auto (green).
3) Start signal received (green).
4) Emergency stop activated (red).
5) Demand mode standby (green).
6) Timing for start (green).
7) Timing for shutdown (green).
8) Generator circuit breaker closed (red).
9) Generator circuit breaker open (green).

a) Generator circuit breaker locked out (white).
b) Generator circuit breaker racked out (white)

10) Remote generator breaker is open (red).
11) Engine stopped (green).
12) Time-delay start (green).
13) Engine running (red).
14) Engine cool-down (green).

b. Pre-Alarm, Light and Horn (Nonlatching):

1) Pre-high coolant temperature (amber).
2) Pre-low oil pressure (amber).
3) Low coolant temperature (amber).
4) Engine low battery (amber).
5) Battery charger failure (amber).
6) Auxiliary power failure (amber).
7) Low fuel-day tank (amber).
8) Paralleling low-voltage switchgear generator breaker failed to close (amber).
9) Paralleling low-voltage switchgear generator breaker failed to open (amber).
10) Overcurrent alarm (amber).
11) Day tank low-fuel alarm (amber).
12) Ground-fault alarm (amber).

c. Shutdown Alarm, Light and Horn (Latching):

1) Engine overcrank (red).
2) Engine overspeed (red).
3) Engine low oil pressure (red).
4) Engine high coolant temperature (red).
5) Engine low coolant level (red).
6) Engine remote emergency shutdown (red).
7) Generator fail to synchronize shutdown (red).
8) Generator circuit breaker tripped (red).
9) Generator circuit breaker failure (red).
10) Generator not in auto (red).
11) Generator loss of field (red).
12) Generator reverse power (red).
13) Generator undervoltage (red).
14) Generator overvoltage (red).
15) Generator underfrequency (red).
16) Generator overfrequency (red).
17) Phase rotation (red).
18) Generator short circuit (red)
19) Day tank low-fuel shutdown (red).
20) Air damper activated, shutdown (red).

S. Paralleling Controls and Protection:

1. Engine Generator Governor (Speed Control and Load Sharing): Comply with requirements in applicable engine generator Section. Components must be Woodward compatible.
2. Kilowatt Load Sharing Control and Interface:

a. Operates engine generator governors during synchronizing and provides isochronous load sharing when paralleled.
b. Allows engine generator to ramp up to kilowatt load level[**signaled by multiple-generator monitoring and control controller**].

3. Load-Demand Governing Control:

a. Causes engine generator to ramp down at operator-adjustable rate to zero load when signaled to shut down in load-demand mode.
b. Causes engine generator to ramp up at operator-adjustable rate to proportional share of total isolated paralleling bus load when signaled to restart.

4. Kilovolt-Ampere-Reactive Load Sharing Control:

a. Operates alternator excitation system while engine generator is paralleled.
b. Causes sharing of reactive load among engine generators to within 1 percent of equal levels without voltage drop.

5. Paralleling Monitor and Control:

a. Monitors and verifies that engine generator has reached 90 percent of nominal voltage and frequency before closing to isolated paralleling bus.
b. Prevents accidental closure of breaker with engine generator out of phase with bus.
c. Prevents out-of-phase closure to isolated paralleling bus due to errant manual or automatic operation of synchronizer.
d. System of diagnostic digital displays to assist in analyzing synchronization.

6. Synchronizer Control:

a. Adjusts engine governor to match voltage, frequency, and phase angle of isolated paralleling bus.
b. Maintains engine generator voltage within 1 percent of isolated paralleling bus voltage, and phase angle within 20 electrical degrees of isolated paralleling bus for 0.5 seconds before circuit-breaker closing.
c. Provides "fail-to-synchronize time delay" adjustable from 10 to 120 seconds; with field selectivity to either initiate alarm or shut down engine generator on failure condition.

7. Reverse Power Monitor and Control:

a. Prevents sustained reverse power flow in engine generator.
b. Trips generator paralleling circuit breaker and initiates engine generator shutdown when reverse power condition exceeds 10 percent of engine generator kilowatt for three seconds.
c. Trips generator paralleling circuit breaker and initiates engine generator shutdown when reverse kilovolt-ampere conditions exceeds 20 percent of generator kilovolt-ampere rating.

8. Phase Rotation Monitor and Control: Verifies engine generator and isolated paralleling bus phase rotation match prior to closing paralleling circuit breaker.
9. Electronic Alternator Overcurrent Alarm and Shutdown Control:

a. Monitors current flow at engine generator output terminals.
b. Initiates alarm when load current on engine generator is more than 110 percent of rated current for more than 60 seconds.
c. Overcurrent shutdown function matched to thermal damage curve of alternator.

10. Electronic Alternator Short-Circuit Protection: Shuts down generator, without instantaneous-trip function, when load current is more than 175 percent of rated current and combined time/current approaches thermal damage curve of alternator.
11. Loss of Excitation Monitor: Displays alarm on single-generator paralleling monitoring and control panel when generator controls sense loss of excitation to alternator while paralleled to isolated paralleling bus.
12. Cool-Down, Time-Delay Control: Adjustable, zero to 600 seconds.
13. Start Time-Delay Control: Adjustable, zero to 300 seconds.
14. Frequency Control: Initiate alarm condition when engine generator is below 90 percent of rated frequency for more than 20 seconds or is over frequency.
15. Under- and Overvoltage Control: Initiate alarm condition when engine generator is at 90 percent voltage for more than 20 seconds or is over voltage.

2.6 METAL-ENCLOSED, CIRCUIT-BREAKER SWITCHGEAR (600 V AND LESS)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain paralleling low-voltage switchgear from same manufacturer as required for [**engine generator**][**transfer switches**][**transfer switches and engine generators**].

D. Description: Factory assembled and tested, and complying with IEEE C37.20.1 and UL 1558.

E. Ratings: Suitable for application in three-phase, 60 Hz, solidly grounded neutral system.

F. Nominal System Voltage: [**480 V, three**][**480/277 V, four**][**240 V, three**][**208/120 V, four**] wire, 60 Hz.

G. Isolated Paralleling Bus: [**5000 A**][**4000 A**][**3200 A**][**2000 A**][**1600 A**]<**Insert amperes**>.

1. Phase-, Neutral-, and Ground-Bus Materials:

   a. Phase[**and Neutral**] Bus: [**Copper, silver plated at connection points**][**Copper, tin plated**][**Aluminum, tin plated**].
   b. Ground Bus: Copper[**, silver**][**, tin**] plated; minimum size **1/4 by 2 inch (6 by 50 mm)**.

2. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.

   a. Uniform capacity for horizontal and vertical bus.
   b. Neutral Bus: [**50**][**100**] percent of phase-bus ampacity, except as indicated. [**Equip bus with pressure-connector terminations for outgoing neutral conductors**][**Include braces for neutral-bus extensions for busway feeders**].
   c. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.

H. Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

I. Switchgear Fabrication:

1. Bus isolation barriers must be arranged to isolate line bus from load bus at main and tie circuit breaker.
2. Circuit-breaker compartments must be equipped to house drawout-type circuit breakers and must be fitted with hinged outer doors.
3. Auxiliary Compartments: Match and align with basic switchgear assembly.

a. Bus transition sections.
b. Pull sections.
c. Hinged front panels for access to accessory and blank compartments.
d. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers; and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.

1) Set pull box back from front to clear circuit-breaker lifting mechanism.
2) Bottom: Insulating, fire-resistive material with separate holes for cable drops into switchgear.
3) Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

e. Neutral Disconnect Link: Bolted, uninsulated, **1/4 by 2 inch (6 by 50 mm)** copper bus, arranged to connect neutral bus to ground bus.
f. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
g. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.

1) Sprayed Insulation Thickness: **3 mil (0.08 mm)**, minimum.
2) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

4. Circuit-Breaker Terminals for Cable Connections: Silver-plated copper bus extensions equipped with pressure connectors for conductors.

J. Circuit Breakers: Comply with IEEE C37.13, IEEE C37.16, and IEEE C37.17.

1. Ratings: As indicated for continuous, interrupting, and short-time current ratings for circuit breaker; voltage and frequency ratings same as switchgear.
2. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

a. Normal Closing Speed: Independent of both control and operator.
b. Slow Closing Speed: Optional with operator for inspection and adjustment.

3. Stored-Energy Mechanism: Electrically charged, with optional manual charging[**and operation counter**].
4. Trip Devices:

a. Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, and release mechanism.
b. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
c. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
d. Time-Current Characteristics: Field adjustable.
e. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or combination of these methods.
f. Long-Time- and Short-Time-Delay Functions: Three bands, minimum; marked "minimum," "intermediate," and "maximum."
g. Pickup Points:

1) Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip

function for switchable I-squared-t operation.
2) Five minimum, for instantaneous-trip functions.

h. Ground-fault protection[**alarm**] with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:

1) Three-wire circuit or system.
2) Four-wire circuit or system.
3) Four-wire, double-ended substation.

i. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

5. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated, consisting of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to terminal block in stationary housing.
6. Drawout Features: Circuit-breaker mounting assembly equipped with racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions.

a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed.
b. Circuit-Breaker Positioning:

1) An open circuit breaker may be racked to or from connected, test, and disconnected positions only with associated compartment door closed, unless live parts are covered by full dead-front shield.
2) An open circuit breaker may be manually withdrawn to position for removal from structure with door open.
3) Status for connection devices for different positions includes the following:

a) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
b) Disconnected Position: Primary and secondary devices and ground contact disengaged.

7. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position; arranged to permit inspection of contacts without removing circuit breaker from switchgear.
8. Padlocking Provisions: For installing at least three padlocks on circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
9. Operating Handle: One for each circuit breaker capable of manual operation.

a. Generator Paralleling Circuit Breakers: Interlocked with system control so that circuit breaker does not close unless mode selector switch is in "Auto" position and engine generator is synchronized with isolated paralleling bus.

10. Electric Close Button: One for each electrically operated circuit breaker.

a. Generator Paralleling Circuit Breakers: Interlocked with system control so that circuit breaker does not close unless mode selector switch is in "Auto" position and engine generator is synchronized with isolated paralleling bus.

11. Mechanical Interlocking of Circuit Breakers: Uses mechanical tripping lever or equivalent design and electrical interlocks.
12. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are

included where future installation of key-interlock devices is indicated.

13. Undervoltage Trip Devices:

    a. Instantaneous, with adjustable pickup voltage.
    b. Adjustable time-delay and pickup voltage.

14. Shunt-Trip Devices:

    a. 24 V(dc) for generator paralleling circuit breakers and for distribution paralleling switchgear circuit breakers.
    b. Where indicated.

15. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

K. Metering:

1. Type and Locations:

    a. Isolated Paralleling Bus: [**Multifunction digital-metering monitor;**][**Analog metering for voltage, amperage, frequency, watt-hour, and recording demand;**] on door of separate metering compartment.
    b. Generator Circuit Breakers: [**Multifunction digital-metering monitor;**][**Analog metering for voltage, amperage, frequency, watt-hour, and recording demand;**] on circuit-breaker door.
    c. Distribution Circuit Breakers: [**Multifunction digital-metering monitor;**][**Analog metering for voltage, amperage, frequency, watt-hour, and recording demand;**] on circuit-breaker door.

2. Instrument Transformers:

    a. Comply with IEEE C57.13.
    b. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
    c. Current Transformers:

        1) Burden and accuracy class suitable for connected relays, meters, and instruments.
        2) Size for maximum momentary current amperage based on calculation or momentary rating of circuit breaker protecting conductor.
        3) Include shorting-type terminal blocks.

3. Multifunction Digital-Metering Monitor:

    a. Microprocessor-based unit suitable for three- or four-wire systems.
    b. Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
    c. Switch-selectable digital display with the following features:

        1) Phase Currents, Each Phase: Plus or minus 1 percent.
        2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
        3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
        4) Three-Phase Real Power: Plus or minus 2 percent.
        5) Three-Phase Reactive Power: Plus or minus 2 percent.
        6) Power Factor: Plus or minus 2 percent.
        7) Frequency: Plus or minus 0.5 percent.

8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
9) Accumulated energy, in **MWh (MJ)**, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

d. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring."
e. Mounting: Display and control unit that is flush or semirecessed mounted in instrument compartment door.

4. Analog Instruments: Rectangular, **4-1/2 inch (115 mm)** square, accurate within 1 percent of full scale range; semirecessed mounting, with antiparallax 250-degree scale and external adjustment.

a. Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.
b. Voltmeter Selector Switch: Rotary type with off position; provides readings of phase-to-phase[**and phase-to-neutral**] voltages.
c. Ammeters: Cover expanded scale range of bus rating plus 10 percent.
d. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
e. Watt-Hour Meters: Flush- or semirecessed-mounting type, [**5 A, 120 V, three phase, three wire; with three elements**]<**Insert characteristics**>, [**15-minute**]<**Insert value**> indicating demand register, and provision for testing and adding pulse initiation.
f. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with [**15-minute**]<**Insert value**> interval.

1) Operation: Counts and records succession of pulses entering two channels.
2) Housing: Drawout type, back-connected case arranged for semirecessed mounting.

L. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.

1. Functions: <**Insert functions**>.
2. Characteristics: <**Insert characteristics**>.

M. Door-Mounted Control Components: Industrial-type oiltight devices and digital-display indicator lamps.

N. Control Power Supply:

1. Control power transformer must supply 120 V(ac) control circuits from generator source through secondary disconnect devices.
2. Include control power transformer for generator paralleling switchgear circuit breaker connected to generator side of circuit breaker.
3. Include control power transformer for distribution paralleling switchgear circuit breaker.
4. Dry-type transformers must be in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
5. Two control power transformers in separate compartments with necessary interlocking relays; transformer must be connected to line side of associated main circuit breaker.

a. Secondary windings must be connected through relay(s) to control bus to effect automatic transfer scheme.
b. Secondary windings must be connected through internal automatic transfer switch to paralleling switchgear control power bus.

6. Control Power Fuses: Primary and secondary fuses must provide current-limiting and overload protection.

O. Control Wiring:

1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Conductors must be sized in accordance with NFPA 70 for duty required.

P. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

Q. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems" for electrical identification devices and installation.

1. Identify units, devices, controls, and wiring.
2. Mimic Bus: Continuous mimic bus, applied to front of paralleling low-voltage switchgear, arranged in one-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

    a. Mimic-bus segments coordinated with devices in paralleling low-voltage switchgear sections to which applied, to produce concise visual presentation of principal paralleling switchgear components and connections.
    b. Medium: Painted graphics, as selected by Architect.
    c. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

R. Indoor Enclosure Material: Steel.

S. Outdoor Enclosure Fabrication Requirements: Galvanized steel, weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating.

1. Features for Compartment or Group of Compartments:

    a. Thermostatically controlled air-conditioning units sized to prevent temperatures exceeding [**80 deg F (27 deg C)**]<**Insert temperature**>.
    b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
    c. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
    d. Hinged front door with locking provisions.
    e. Interior light with switch.
    f. Weatherproof ground-fault circuit-interrupter duplex receptacle.
    g. Power for air conditioning, heaters, lights, and receptacles to be provided from control power transformer.

2. Features for Weatherproof Internal Aisle Construction:

    a. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
    b. Aisle access doors with exterior padlocking provisions and interior panic latches.
    c. Thermostatically controlled aisle space heaters operating at one-half or less of rated voltage.
    d. Thermostatically controlled, aisle air-conditioning units sized to prevent temperatures exceeding **104 deg F (40 deg C)**.
    e. Vaporproof, fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at entrance.
    f. At least two duplex, ground-fault circuit-interrupter receptacles, located in aisle.

g. Aisle ventilation louvers arranged with makeup air near floor level and exhaust air near roof level.

1) Louvers must have insect and rodent screen and filter, arranged to permit air circulation while excluding insects, rodents, and exterior dust.
2) Exhaust fans.

T. Access: Fabricate enclosure with hinged, rear cover panels to allow access to rear interior of paralleling low-voltage switchgear.

U. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

2.7 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

1. Perform successfully tests prior to witness test.

B. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate paralleling switchgear.

C. [**Factory**]Tests and Inspections: Test and inspect paralleling low-voltage switchgear, with [**generators**][**generators and transfer switches**], by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with {Insert standards} before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance on control units.

1. Paralleling Low-Voltage Switchgear:

a. NETA ATS, 7.6.1.2, "Circuit Breaker, Air, Low-Voltage Power Switchgear."
b. Factory test with simulated inputs. Test control and relay functions for proper operation.

2. Engine Generator:

a. NETA ATS, 7.22.1, "Emergency Systems, Engine Generator."
b. NETA ATS, 7.15.1, "Rotating Machinery, AC Motors & Generator."

3. Automatic Transfer Switches:

a. NETA ATS, 7.22.3, "Emergency System, Automatic Transfer Switches."

D. Verification of Performance: Rate paralleling low-voltage switchgear, with [**generators**][**generators and transfer switches**], in accordance with operation of functions and features specified.

E. Nonconforming Work:

1. Paralleling low-voltage switchgear, with [**generators**][**generators and transfer switches**], will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, where paralleling low-voltage switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF SWITCHGEAR COMPONENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for paralleling low-voltage switchgear, including clearances between paralleling switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

3.3 INSTALLATION

A. Comply with applicable portions in NECA 400.

B. Equipment Mounting:

1. Install paralleling low-voltage switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 260529 "Hangers and Supports for Electrical Systems."
2. Comply with requirements for seismic control devices specified in [**Section 260548 "Vibration and Seismic Controls for Electrical Systems."**][**Section 260548.16 "Seismic Controls for Electrical Systems."**]

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from paralleling low-voltage switchgear units and components.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

B. Diagrams and Instructions:

1. Frame and mount under clear acrylic plastic on front of paralleling low-voltage switchgear.

a. Operating Instructions: Printed basic instructions for paralleling low-voltage switchgear, including control and key-interlock sequences and emergency procedures.
b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include rack or holder, near operating instructions, for copy of maintenance manual.

C. Compartment Nameplates: [**Engraved, laminated acrylic**][**Engraved, melamine plastic**][**Preprinted**

aluminum], as described in Section 260553 "Identification for Electrical Systems," for compartment, mounted with corrosion-resistant screws.

D. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as selected by Architect.
3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

E. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce **3.5-by-5-inch (76-by-127-mm)** self-adhesive equipment label for each work location included in analysis.
2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce **3.5-by-5-inch (76-by-127-mm)** self-adhesive equipment label for each work location included in analysis. Labels must be machine printed, with no field-applied markings.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

b. Labels must be machine printed, with no field-applied markings.

3.5 CONNECTIONS

A. Comply with grounding and bonding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with wire and cable requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation: Prepare for acceptance tests as follows:

1. Test insulation resistance for switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of circuit.
3. Inspect paralleling switchgear installation, including wiring, components, connections, and equipment.[**Test and adjust components and equipment.**]
4. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing.
5. Complete installation and startup checks in accordance with manufacturer's written instructions.

B. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Perform visual and mechanical inspections and electrical tests stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for the following NETA categories:

a. AC generators and emergency systems.
b. Switchgear.
c. Circuit breakers.
d. Instrument transformers.
e. Metering and instrumentation.
f. Ground-fault systems.
g. Battery systems.
h. Surge arresters.
i. Capacitors.

2. Perform NFPA 110 tests for Type 1 essential power systems.
3. Test sequence of operation step by step for each mode.

D. Nonconforming Work:

1. Paralleling low-voltage switchgear will be considered defective if it does not pass tests and inspections.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.7 ADJUSTING

A. Set field-adjustable, electronic circuit-breaker trip characteristics in accordance with results specified in Section 260573.16 "Coordination Studies."

B. Set field-adjustable, electronic circuit-breaker trip characteristics.

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of paralleling low-voltage switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to paralleling low-voltage switchgear, in accordance with manufacturer's written instructions, throughout periods when paralleling switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.10 MAINTENANCE

A. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of switchgear 11 months after date of Substantial Completion.
2. Instrument: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 21 16 00

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Task	Specification	Specification Description
26 21 16 00	26 05 13 00	Medium-Voltage Cables
26 21 16 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
26 22 00 00	26 12 19 00a	Low-Voltage Switchgear

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SECTION 26 22 13 00 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. <**Insert products installed, but not furnished**>.

D. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS[**TO BE MODIFIED**][**TO BE REMOVED AND RE-INSTALLED**]

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Acme Electric; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
3. [**Dongan Electric Manufacturing Company**]
4. [**Eaton**]
5. [**Federal Pacific**]
6. [**Hammond Power Solutions Inc.**]
7. [**Jefferson Electric, Inc.**]
8. [**Lincoln Electric Products Co., Inc.**]
9. [**Mag-Tran; a division of Quality Transformer & Electronics**]
10. [**Marcus Transformer LTD**]
11. [**MGM Transformer Company**]
12. [**Micron Industries Corporation**]
13. [**Mirus International Inc.**]
14. [**Powersmiths International Corp.; Socomec Group**]
15. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
16. [**Rex Power Magnetics**]
17. [**Siemens Industry, Inc., Energy Management Division**]
18. [**SolaHD; Emerson Electric Co., Automation Solutions**]
19. [**Square D; Schneider Electric USA**]
20. [**TEMCo Transformers**]
21. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Acme Electric; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
3. [**Dongan Electric Manufacturing Company**]
4. [**Eaton**]
5. [**Federal Pacific**]
6. [**Hammond Power Solutions Inc.**]
7. [**Jefferson Electric, Inc.**]
8. [**Lincoln Electric Products Co., Inc.**]
9. [**Mag-Tran; a division of Quality Transformer & Electronics**]
10. [**Marcus Transformer LTD**]
11. [**MGM Transformer Company**]
12. [**Micron Industries Corporation**]
13. [**Mirus International Inc.**]
14. [**Powersmiths International Corp.; Socomec Group**]
15. [**Prolec GE; A Xignux and General Electric Company Joint Venture**]
16. [**Rex Power Magnetics**]
17. [**Siemens Industry, Inc., Energy Management Division**]
18. [**SolaHD; Emerson Electric Co., Automation Solutions**]
19. [**Square D; Schneider Electric USA**]
20. [**TEMCo Transformers**]
21. <**Insert manufacturer's name**>

C. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.4 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.5 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70[**, and list and label as complying with UL 1561**].

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Core volume must allow efficient transformer operation at 10 percent above nominal tap voltage.
3. Grounded to enclosure.

C. Coils: Continuous windings[**without splices**] except for taps.

1. Coil Material: [**Aluminum**][**Copper**].
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: [**Welded**][**Bolted**].

D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.

E. Enclosure: [**Ventilated**][**Totally enclosed, nonventilated**].

1. Core and coil must be encapsulated within resin compound[**using vacuum-pressure impregnation process**] to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Environmental Protection:

a. Indoor: UL 50E, [**Type 2**][**Type 3R**][**Type 4X, Stainless Steel**].
b. Outdoor: UL 50E, [**Type 3R**][**Type 4X**][**Type 4X, Stainless Steel**].

5. Finish Color: [**Gray**][**ANSI 49 gray**][**ANSI 61 gray**] weather-resistant enamel.

F. Taps for Transformers 3 kVA and Smaller: [**None**][**One 5 percent tap above normal full capacity**].

G. Taps for Transformers 7.5 to 24 kVA: [**One 5 percent tap above and one 5 percent tap below normal**

full capacity][**Two 5 percent taps below rated voltage**].

H. Taps for Transformers 25 kVA and Larger: [**Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity**][**Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity**].

I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of [**150 deg C**][**115 deg C**][**80 deg C**] rise above 40 deg C ambient temperature.

K. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

L. K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to degree defined by designated K-factor.

1. Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding indicated insulation class in 40 deg C maximum ambient and 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit must comply with requirements of DOE 2016 efficiency levels when tested in accordance with NEMA TP 2 with K-factor equal to one.

M. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding shield.

N. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

O. Wall Brackets: [**Manufacturer's standard brackets**][**Wall brackets fabricated from design drawings signed and sealed by qualified structural professional engineer**].

P. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: [**40 dB(A-weighted)**]<**Insert dB(A-weighted)**>.
2. 9.01 to 30.00 kVA: [**45 dB(A-weighted)**]<**Insert dB(A-weighted)**>.
3. 30.01 to 50.00 kVA: [**45 dB(A-weighted) for K-factors of 1, 4, and 9**][**48 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
4. 50.01 to 150.00 kVA: [**50 dB(A-weighted) for K-factors of 1, 4, and 9**][**53 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
5. 150.01 to 300.00 kVA: [**55 dB(A-weighted) for K-factors of 1, 4, and 9**][**58 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
6. 300.01 to 500.00 kVA: [**60 dB(A-weighted) for K-factors of 1, 4, and 9**][**63 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
7. 500.01 to 700.00 kVA: [**62 dB(A-weighted) for K-factors of 1, 4, and 9**][**65 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
8. 700.01 to 1000.00 kVA: [**64 dB(A-weighted) for K-factors of 1, 4, and 9**][**67 dB(A-weighted) for K-factors of 13 and 20**]<**Insert dB(A-weighted)**>.
9. 1000.01 to 1500.00 kVA: <**Insert dB(A-weighted)**>.

2.6 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
2. Self-adhesive label for distribution transformers. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate transformer.

B. Factory Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance on control units.

1. Resistance measurements of windings at rated voltage connections and at tap connections.
2. Ratio tests at rated voltage connections and at tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

    a. Line-side to ground.
    b. Load-side to ground.
    c. Line-side to load-side.

9. Temperature tests.
10. Factory Sound-Level Tests: [**Conduct sound-level tests on equipment for this Project**][**Conduct prototype sound-level tests on production-line products**].

C. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated [**by transformer manufacturer**][**from design drawings signed and sealed by qualified structural professional engineer**].

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
2. Brace wall-mounted transformers as specified in [**Section 260548 "Vibration and Seismic Controls for Electrical Systems."**][**Section 260548.16 "Seismic Controls for Electrical Systems."**]

B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions[**, seismic requirements applicable to Project,**] and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base in accordance with manufacturer's published instructions.

E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-

tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

2. Large (Larger Than 167 kVA Single Phase or 500 kVA Three Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform power-factor or dissipation-factor tests on windings.
4) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
5) Perform excitation-current test on each phase.
6) Perform applied voltage test on line- and load-side windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
7) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

E. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Assemble and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.5 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.

1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 22 13 00

Task	Specification	Specification Description
26 22 13 00	26 12 19 00a	Low-Voltage Switchgear

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SECTION 26 24 13 00 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.

B. Related Requirements

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.2 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge protection devices.
4. Groud-fault protection devices.
5. Accessories.
6. Other components.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and

service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Field Quality-Control Submittals:

1. Field Quality-Control Reports:

a. Test procedures used.
b. Test results that comply with requirements.
c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Handling, storing, and providing temporary heat.
2. Mounting accessories and anchoring devices.
3. Testing and adjusting overcurrent protective devices.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.

2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
2. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
3. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.
4. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.
5. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and [**install temporary electric heating (250 W per section)**][**connect factory-installed space heaters to temporary electrical service**] to prevent condensation.

C. Handle and prepare switchboards for installation in accordance with [**NECA 400**][**NEMA PB 2.1**].

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that switchboard performs in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial

Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

I. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: [**Panel**][**Fixed, individually**] mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

J. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.

2. Branch Devices: Panel mounted.
3. Section Alignment: [**Front**][**and**][**Rear**] aligned.

K. Front- and Rear-Accessible Switchboards:

1. Main Devices: [**Fixed, individually**][**Drawout**] mounted.
2. Branch Devices: [**Panel**][**Fixed, individually**][**Panel and fixed, individually**][**Fixed and individually compartmented**][**Individually compartmented and drawout**] mounted.
3. Sections [**front and rear**][**rear**] aligned.

L. Nominal System Voltage: [**480Y/277 V**][**208Y/120 V**]<**Insert system voltage**>.

M. Main-Bus Continuous: [**5000**][**4000**][**3000**][**2500**][**2000**][**1600**][**1200**]<**Insert ampere rating**> A.

N. Indoor Enclosures: Steel, UL 50E, [**Type 1**][**Type 2**].

O. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's [**standard gray**][**custom color**] finish over rust-inhibiting primer on treated metal surface.

P. Outdoor Enclosures: [**Type 3R**][**Type 3R, with interior-lighted walk-in aisle**].

1. Finish: Factory-applied finish in manufacturer's [**standard**][**custom**] color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: [**Flat**][**Downward, rearward sloping**] roof; [**bolt-on rear covers**][**rear hinged doors**] for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of [**30 inch (762 mm)**]<**Insert value**>; opening outwards; with panic hardware and provisions for [**padlocking**][**cylinder lock**]. At least one door must be sized to permit largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
4. Accessories: LED luminaires, ceiling mounted; wired to three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack luminaire installed on wall of aisle midway between personnel doors.
5. Walk-in Aisle Heating and Ventilating:

    a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of [**40 deg F (5 deg C)**]<**Insert temperature**> with outside design temperature of [**0 deg F (minus 18 deg C)**]<**Insert temperature**>.
    b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of [**100 deg F (38 deg C)**]<**Insert temperature**> with outside design temperature of [**90 deg F (32 deg C)**]<**Insert temperature**>.
    c. Ventilating openings[**complete with replaceable fiberglass air filters**].
    d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include control-power transformer, with spare capacity of 25 percent, within switchboard. Supply voltage must be [**120 V(ac)**][**120/240 V(ac)**][**120/208 V(ac)**].
7. Power for space heaters, ventilation, lighting, and receptacle provided by remote source.

Q. Barriers: Between adjacent switchboard sections.

R. Insulation and isolation for[**main bus of main section and**] main and vertical buses of feeder sections.

S. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: [**Thermostats to maintain temperature of each section above expected dew point**][**Manual switching of branch-circuit protective device**].
2. Space-Heater Power Source: [**Transformer, factory installed in switchboard**][**120 V external branch circuit**].

T. Service Entrance Rating: Switchboards intended for use as service entrance equipment may contain from one to six service disconnecting means with overcurrent protection, neutral bus with disconnecting link, grounding electrode conductor terminal, and main bonding jumper.

U. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

V. Customer Metering Compartment: Separate customer metering compartment[**and section with front hinged door,**] and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring must be terminated on shorting-type terminal blocks.[**Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.**]

W. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

X. Removable, Hinged Rear Doors and Compartment Covers: Secured by [**captive thumb screws**][**standard bolts**], for access to rear interior of switchboard.

Y. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Z. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers may form top, front, and sides. Top covers at rear must be easily removable for drilling and cutting.
4. Bottom must be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports must be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

AA. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
2. Phase- and Neutral-Bus Material:

    a. Hard-drawn copper of 98 percent conductivity[**, silver-plated**].
    b. Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.

3. Copper feeder circuit-breaker line connections.
4. Tin-plated aluminum feeder circuit-breaker line connections.
5. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with [**mechanical**][**compression**] connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

6. Ground Bus: [1/4 by 2 inch (6 by 50 mm-)][1/4 by 1 inch (6 by 25 mm-)][**Minimum-size required by UL 891,**] hard-drawn copper of 98 percent conductivity, equipped with [**mechanical**][**compression**] connectors for feeder and branch-circuit ground conductors.
7. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
8. Disconnect Links:

    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

9. Neutral Buses: [**50**][**100**] percent of ampacity of phase buses unless otherwise indicated, equipped with [**mechanical**][**compression**] connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
10. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

BB. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

CC. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

DD. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.2 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**Eaton**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**Eaton**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

C. SPDs: Listed and labeled in accordance with UL 1449, [**Type 1**][**Type 2**].

D. Features and Accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.

3. Indicator light display for protection status.
4. Form-C contacts rated at [**5 A and 250 V(ac)**][**2 A and 24 V(ac)**]<**Insert values**>, one normally open and one normally closed, for remote monitoring of protection status.[**Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.**]
5. Surge counter.

E. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than [**200 kA**][**250 kA**][**300 kA**]<**Insert amperes**>. Peak surge current rating must be arithmetic sum of ratings of individual MOVs in each mode.

F. Protection modes and UL 1449 VPR for grounded wye circuits with [**480Y/277 V**][**208Y/120 V**], three-phase, four-wire circuits may not exceed the following:

1. Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
2. Line to Ground: [**1200 V for 480Y/277 V**][**1200 V for 208Y/120 V**].
3. Line to Line: [**2000 V for 480Y/277 V**][**1000 V for 208Y/120 V**].

G. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits may not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: [**700 V**][**1000 V**].
3. Line to Line: 1000 V.

H. SCCR: Equal or exceed [**100 kA**][**200 kA**]<**Insert amperes**>.

I. Nominal Rating: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with [**series-connected rating**][**interrupting capacity**] to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long and short time adjustments.
    d. Ground-fault pickup level, time delay, and I squared t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).

7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30 mA trip).
8. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: [**Mechanical**][**Compression**] style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
    g. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at [**55**][**75**] percent of rated voltage.
    h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    i. Auxiliary Contacts: [**One SPDT switch**][**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
    j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): [**80**][**100**] percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. [**Fixed**][**Drawout**] circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. [**Standard**][**Full**]-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Time adjustments for long- and short-time pickup.
    c. Ground-fault pickup level, time delay, and I squared t response.
    d. <**Insert settings**>.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
8. Control Voltage: [**40 V(dc)**][**125 V(dc)**][**250 V(dc)**][**120 V(ac)**].

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on switch blade after it engages stationary contacts.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Boltswitch, Inc.**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Boltswitch, Inc.**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Main-Contact Interrupting Capability: Minimum of 12 times switch current rating.
4. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

5. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
6. Service-Rated Switches: Labeled for use as service equipment.
7. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

a. Configuration: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
b. Internal Memory: Integrates cumulative value of intermittent arcing ground-fault currents and uses effect to initiate tripping.
c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

8. Open-Fuse Trip Device: Arranged to trip switch open if phase fuse opens.

D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. <**Insert manufacturer's name**>

3. Main-Contact Interrupting Capability: Minimum of 12 times switch current rating.
4. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

    a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
    b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

5. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
6. Service-Rated Switches: Labeled for use as service equipment.
7. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

    a. Configuration: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    b. Internal Memory: Integrates cumulative value of intermittent arcing ground-fault currents and uses effect to initiate tripping.
    c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

8. Open-Fuse Trip Device: Arranged to trip switch open if phase fuse opens.

E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

F. Fuses are specified in Section 262813 "Fuses."

2.4 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, [**single**][**tapped**][**double**] secondary; disconnecting type with integral fuse mountings. Burden and accuracy must be consistent with connected metering and relay devices.
2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; [**wound**][**bushing**][**bar or window**] type; [**single**][**double**] secondary winding and secondary shorting device. Burden and accuracy must be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

    a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    d. Megawatts: Plus or minus 1 percent.
    e. Megavars: Plus or minus 1 percent.
    f. Power Factor: Plus or minus 1 percent.
    g. Frequency: Plus or minus 0.1 percent.
    h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Analog Meters:

1. Meters: **4 inch (100 mm)** diameter or **6 inch (150 mm)** square, flush or semiflush, with anti-parallax 250-degree scales and external zero adjustment.

D. Voltmeters: Cover expanded-scale range of nominal voltage plus 10 percent.

E. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of phase-to-phase voltages and, where neutral is indicated, phase-to-neutral voltages.
2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in closed-circuit condition at all times.

F. Ammeters: **2-1/2 inch (64 mm)** minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

G. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semiflush mounted case with matching cover.
12. Appropriate multiplier tag.

H. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.

3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording [**five**][**15**][**30**]<**Insert time period**>-minute integrated demand of totalized system.

2.5 CONTROL POWER

A. Control Circuits:

1. 120 V(ac), supplied through secondary disconnecting devices from control-power transformer.
2. 120 V(ac), supplied from remote branch circuit.
3. <**Insert control voltage**> V(dc).

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to primary side of each control-power transformer at line side of associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards in accordance with [**NECA 400**][**NEMA PB 2.1**].

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage in accordance with manufacturer's published instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and

other conditions affecting performance of the Work or that affect performance of equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with [**NECA 400**][**NEMA PB 2.1**].
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, **4 inch (100 mm)** nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."

    a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend **2 inch (50 mm)** above concrete base after switchboard is anchored in place.
    b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18 inch (450 mm)** centers around full perimeter of concrete base.
    c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to switchboards.
    f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
5. Install filler plates in unused spaces of panel-mounted sections.
6. Install overcurrent protective devices, surge protection devices, and instrumentation.

    a. Set field-adjustable switches and circuit-breaker trip ranges.

7. Install spare-fuse cabinet.

3.4 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

C. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.

D. Support and secure conductors within switchboard in accordance with NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.5 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Mimic Bus:

1. Entire single-line switchboard bus work, as depicted on factory record drawing, on minimum **0.032 inch (0.813 mm)** thick anodized aluminum photoengraved nameplate, located at eye level on front cover of switchboard incoming service section.
2. Entire single-line switchboard bus work, as depicted on factory record drawing, on engraved minimum **0.0625 inch (1.588 mm)** thick laminated-plastic (Gravoply) nameplate, located at eye level on front cover of switchboard incoming service section.
3. Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
4. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce concise visual presentation of principal switchboard components and connections.
5. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

E. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.6 FIELD QUALITY CONTROL

A. [**Acceptance**]Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Acceptance Testing:

a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove [**front**][**front and rear**] panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Nonconforming Work:

1. Switchboard will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges [**as indicated.**][**as specified in Section 260573.16**

"Coordination Studies."]

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 26 24 13 00

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Task	Specification	Specification Description
26 24 13 00	26 27 13 00	Electricity Metering
26 24 13 00	26 28 16 00	Enclosed Switches And Circuit Breakers

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SECTION 26 24 16 00 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panelboards.
2. Disconnecting and overcurrent protective devices.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**> .

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
7. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, and arc-flash hazard analysis studies.
8. Section 260913 "Electrical Power Monitoring" specifies power monitoring and control systems installed by this Section.
9. Section 262813 "Fuses" specifies fuses and spare-fuse cabinets installed by this Section.
10. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies Type 1 and Type 2 surge protective devices installed by this Section.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. SPD: Surge protective device.

C. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.
3. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.
4. Include manufacturer's sample extended warranty language.

B. Shop Drawings: For each panelboard and related equipment.

1. Include plans, elevations, sections, details, and attachments to other Work.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field Quality Control Reports: For specified tests and inspections.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. [**Submit final versions after load balancing.**]

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.
3. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.7 QUALIFICATIONS

A. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with [**NECA 407**][**NEMA PB 1**] .

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials [**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**] , freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**> .

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**> .

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**> .

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**> .

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**> .

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**> .

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces specified in Section 018123 "Facility Seismic and Wind Criteria."

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Comply with NEMA PB 1.

E. Enclosures: [**Flush**][**and**][**Surface**] -mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: UL 50E, [**Type 1**]<**Insert type**> .
b. Outdoor Locations: UL 50E, [**Type 3R**]<**Insert type**> .
c. Kitchen and Wash-Down Areas: UL 50E, [**Type 4X**]<**Insert type**> , [**stainless steel**]<**Insert material**> .
d. Other Wet or Damp Indoor Locations: UL 50E, [**Type 4**]<**Insert type**> .
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, [**Type 5**][**Type 12**] .

2. Height: **7 ft (2.13 m)** maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

    a. Panels and Trim: [**Steel**][**and**][**galvanized steel**] , factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: [**Galvanized steel**][**Same finish as panels and trim**] .
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

F. Phase, Neutral, and Ground Buses:

1. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**] .

    a. Plating must run entire length of bus.
    b. Bus must be fully rated for entire length.

2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**] .
2. Terminations must allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: [**Compression**][**Mechanical**] type, with lug on neutral bar for each pole in panelboard.
5. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type, with lug on bar for each pole in panelboard.

H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: [**5**][**10**][**20**]<**Insert number**> percent.

J. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction. Include label or manual with size and type of allowable upstream and branch devices listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series-connected short-circuit rating.

    a. Panelboards rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
    b. Panelboards rated above 240 V and less than 600 V must have short-circuit ratings as

shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

   a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
   b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.4 PANELBOARDS

A. UL QEUY - Distribution Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Electrification Installations Products**]
   b. [**Eaton**]
   c. [**ESL Power Systems, Inc.**]
   d. [**Mersen USA**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**Eaton**]
   c. [**ESL Power Systems, Inc.**]
   d. [**Mersen USA**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Distribution Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

   a. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

      1) For doors more than [**36 inch (914 mm)**]<**Insert dimension**> high, provide two latches, keyed alike.

b. Mains: [**Circuit breaker**][**Fused switch**][**Lugs only**] .

1) Location: [**Top**][**Bottom**][**Convertible between top and bottom**] .
2) Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

c. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: [**Plug-in circuit breakers**][**Bolt-on circuit breakers**][**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**] .
d. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: [**Bolt-on circuit breakers**][**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**] .
e. Branch Overcurrent Protective Devices: Fused switches.

6. Other Available Features Required by Project:

a. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD [**Type 1**][**Type 2**] .
b. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
c. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
d. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
e. Do not mount neutral bus in gutter.
f. Feed-Through Lugs: [**Compression**][**Mechanical**] type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
g. Subfeed (Double) Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
h. Gutter-Tap Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
i. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
j. Split Bus: Vertical buses divided into individual vertical sections.

1) Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**][**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

a) Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
b) External Control-Power Source: [**120 V branch circuit**][**24 V control circuit**]<**Insert requirement**> .

B. UL QEUY - Lighting and Appliance Branch-Circuit Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]

b. [**Bender Inc.; Bender GmbH & Co. KG**]
c. [**Eaton**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**Bender Inc.; Bender GmbH & Co. KG**]
c. [**Eaton**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Lighting and Appliance Branch-Circuit Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

a. Mains: [**Circuit breaker**][**or**][**lugs only**] .

1) Location: [**Top**][**Bottom**][**Convertible between top and bottom**] .
2) Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

b. Branch Overcurrent Protective Devices: [**Plug-in**][**Bolt-on**] circuit breakers, replaceable without disturbing adjacent units.

6. Other Available Features Required by Project:

a. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD [**Type 1**][**Type 2**] .
b. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
c. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
d. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
e. Do not mount neutral bus in gutter.
f. Feed-Through Lugs: [**Compression**][**Mechanical**] type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
g. Subfeed (Double) Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
h. Gutter-Tap Lugs: [**Compression**][**Mechanical**] type suitable for use with conductor

material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

i. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

j. Split Bus: Vertical buses divided into individual vertical sections.

1) Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**][**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

a) Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

b) External Control-Power Source: [**120 V branch circuit**][**24 V control circuit**]<**Insert requirement**> .

k. Doors: Door-in-door construction with concealed hinges; secured with [**flush**][**or**][**multipoint**] latch with tumbler lock; keyed alike. [**Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.**]

l. Column-Type Panelboards: Single row of overcurrent devices [**with narrow gutter extension**][**and**][**overhead junction box equipped with ground and neutral terminal buses**] .

1) Column-Type Panelboard Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

C. UL QEUY - Electronic-Grade Panelboard :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**Eaton**]
c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Electronic-Grade Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

5. Standard Features:

    a. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
    b. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
    c. Factory-Installed, Integral SPD:

        1) Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than [**100 kA**]<**Insert value**> . Peak surge current rating must be arithmetic sum of ratings of individual MOVs in given mode.
        2) Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits may not exceed the following:

            a) Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
            b) Line to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
            c) Neutral to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**] .
            d) Line to Line: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**] .

        3) Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits may not exceed the following:

            a) Line to Neutral: 700 V.
            b) Line to Ground: 700 V.
            c) Neutral to Ground: 700 V.
            d) Line to Line: 1200 V.

        4) SCCR: Equal to [**SCCR of panelboard in which installed**][**or exceed 100 kA**][**or exceed 200 kA**][**or exceed**]<**Insert value**> .
        5) Inominal Rating: [**20 kA**][**10 kA**] .

    d. Buses:

        1) Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
        2) Copper equipment and isolated ground buses.

    e. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. UL QEUY - Load Center :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ABB Electrification Installations Products**]
    b. [**Eaton**]
    c. [**Siemens Industry, Inc., Energy Management Division**]
    d. [**Square D; Schneider Electric USA**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB Electrification Installations Products**]
    b. [**Eaton**]

c. [**Siemens Industry, Inc., Energy Management Division**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Electronic-Grade Type Panelboards: UL CCN QEUY; including UL 67.

5. Standard Features:

   a. Mains: [**Circuit breaker**][**or**][**lugs only**] .
   b. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
   c. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
   d. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

1. [**ABB Electrification Installations Products**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB Electrification Installations Products**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. MCCB: Comply with UL 489, with [**series-connected rating**][**interrupting capacity**] to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

   a. RMS sensing.
   b. Field-replaceable rating plug or electronic trip.

c. Digital display of settings, trip targets, and indicated metering displays.
d. Multi-button keypad to access programmable functions and monitored data.
e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
f. Integral test jack for connection to portable test set or laptop computer.
g. Field-Adjustable Settings:

1) Instantaneous trip.
2) Long- and short-time pickup levels.
3) Long- and short-time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
6. GFPE Circuit Breakers: Class B ground-fault protection (30 mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: [**Compression**][**Mechanical**] style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: [**Integrally mounted**][**Remote-mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system.
h. Shunt Trip: [**120 V**][**24 V**]<**Insert voltage**> trip coil energized from separate circuit, set to trip at [**55**][**75**] percent of rated voltage.
i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [**on**][**off**][**on or off**] position.
j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
k. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [**without intentional**][**with field-adjustable 0.1- to 0.6-second**] time delay.
l. Rating Plugs: Three-pole breakers with ampere ratings greater than [**150**]<**Insert value**> A must have interchangeable rating plugs or electronic adjustable trip units.
m. Auxiliary Contacts: [**One, SPDT switch**][**Two, SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
n. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
o. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
p. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
q. Multipole units enclosed in [**single housing with single handle**][**or**][**factory assembled to operate as single unit**] .

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Provide fuses and spare fuse cabinet.
2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with manual interlock override, to prevent opening of cover when switch is in on position. Interlock must prevent switch from being turned on with cover open. Operating handle must have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: [**One**][**Two**] normally open and normally closed contact(s) that operate with switch handle operation.

2.6 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Keys: [**Two**]<**Insert number**> spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFPE Types: [**Two**]<**Insert number**> spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
2. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with [**NECA 407**][**NEMA PB 1.1**] .

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PANELBOARDS

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with [**NECA 407**][**NEMA PB 1.1**] .
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting:

   a. Install floor-mounted panelboards on cast-in-place concrete equipment base(s).
   b. Attach panelboard to vertical finished or structural surface behind panelboard.
   c. Mount surface-mounted panelboards to steel slotted supports [**5/8 inch (16 mm)**][**1-1/4 inch (32 mm)**] in depth. Orient steel slotted supports vertically.
   d. Provide seismic control devices.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Provide mounting and anchoring devices.
4. Mount top of trim [**7.5 ft (2.3 m)**]<**Insert height**> above finished floor unless otherwise indicated.
5. Mount panelboard cabinet plumb and rigid without distortion of box.
6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.

   a. Set field-adjustable, circuit-breaker trip ranges.
   b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
9. Install filler plates in unused spaces.
10. Stub four **1 inch (25 mm)** empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four **1 inch (25 mm)** empty conduits into raised floor space or below slab not on grade.
11. Arrange conductors in gutters into groups and bundle and wrap with wire ties [**after completing load balancing**] .
12. Mount spare fuse cabinet in accessible location.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Install warning signs.

C. Panelboard Nameplates: Label each panelboard with nameplate.

D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in [**transparent card holder**][**metal frame with transparent protective cover**] .

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads [**after balancing panelboard loads**] ; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**> .

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers [**and low-voltage surge arrestors**] stated in NETA ATS, Paragraph 7.6 Circuit Breakers [**and Paragraph 7.19.1 Surge Arrestors, Low-Voltage**] . [**Do not perform**][**Perform**] optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

1. Include certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended in writing by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 26 24 16 00

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SECTION 26 24 16 00A - ELECTRONICALLY OPERATED CIRCUIT-BREAKER PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panelboards.
2. Circuit breakers.
3. Main controllers.
4. Slave panel controllers.
5. Control network.
6. Manual switches and cover plates.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and cover plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each electronically operated, circuit-breaker panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for

each type of overcurrent protective device.

7. Include diagrams for power, signal, and control wiring.
8. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
9. Submit evidence that electronic controls are compatible with connected monitoring and control devices and systems specified in other Sections.

    a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
    b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of network protocol.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Electrically Operated, Molded-Case Circuit Breakers: Equal to <**Insert number**> percent of amount installed[**for each size indicated**], but no fewer than <**Insert number**>.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to [**NECA 407**][**NEMA PB 1.1**].

1.6 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that components of panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Two**]<**Insert number**> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Follow-on Extended Warranty Period: [**Five**]<**Insert number**> year(s) from date of Substantial Completion, for materials that failed because of transient voltage surges only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 ELECTRICALLY OPERATED CIRCUIT-BREAKER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Siemens Industry, Inc., Energy Management Division**]
4. [**Square D; Schneider Electric USA**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain electrically operated circuit breakers and power distribution components from single manufacturer.

2.2 SYSTEM DESCRIPTION

A. Input signal from field-mounted or on-board signal source must open or close one or more electrically operated circuit breakers in electronically operated, circuit-breaker panelboards. Any combination of inputs must be programmable to any combination outputs.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by the authorities having jurisdiction, and marked for intended location and application.

C. Comply with 47 CFR Part 15, Subpart A and Subpart B, for Class A digital devices.

2.3 PERFORMANCE REQUIREMENTS

A. Expansion Requirements: Capacity for future expansion of number of control functions by 25 percent of current capacity; to include equipment ratings, housing capacities, spare spaces for circuit breakers, terminals, number of conductors in control cables, and control software.

B. Interface with DDC System for HVAC: Provide hardware and software to enable DDC system for HVAC to monitor, control, display, and record data for use in processing reports.

1. Hardwired Points:

   a. Monitoring: On-off status, <**Insert monitoring point**>.
   b. Control: On-off operation, <**Insert control point**>.

2. Communication Interface: Comply with [**ASHRAE 135**][**ISO/IEC 14908-1**][**"MODBUS Application Protocol Specification"**]<**Insert type of interface**> communication interface with DDC system for HVAC must enable DDC system for HVAC operator to remotely control and monitor electronically operated circuit breakers from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at panelboard controller must be available through DDC system for HVAC.

2.4 PANELBOARDS

A. Electronically operated, circuit-breaker panelboards may contain remotely operated circuit breakers and standard branch circuit breakers specified in Section 262416 "Panelboards."

B. Assemblies: Comply with UL 67 and NEMA PB 1.

C. Surge Protective Device:

1. Field mounted, complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Integrally mounted, complying with UL 1449 Type 1.

a. Comply with IEEE C62.41, Category C, 200 kA short-circuit current rating.
b. Non-modular type with the following features and accessories:

1) Digital-display indicator lights for power and protection status.
2) <**Insert features and accessories**>.

D. Enclosures: Comply with UL 50.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by a qualified electrical testing laboratory. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected, short-circuit rating by a qualified electrical testing laboratory.
2. Fully rated to interrupt [**10 kA**]symmetrical short-circuit current available at terminals.

2.5 CIRCUIT BREAKERS

A. Remotely operated branch circuit breakers must provide branch circuit overcurrent protection.

B. Labeled with SWD and HID Ratings: Comply with UL 489 for 15 and 20 A, single-pole branch devices.[**15 and 20 A circuit breakers, if scheduled, must be a product of same manufacturer, and be of same class as rated circuit breakers.**]

C. Switching Endurance Rating: Not less than [**50,000**][**200,000**]<**Insert number**> full-load open/close/open remote operations.

D. Remotely Operated Circuit Breakers: Manual override switch or handle position must enable or disable remote operation of device and allow breaker handle to manually control breaker's on-off status.

2.6 MAIN CONTROLLERS

A. Description: Controllers must contain power supply and electronic control for operating and monitoring remotely operated branch circuit breakers.

1. Comply with UL 916 (CSA C22.2, No. 205); with a microprocessor-based, solid-state, 365-day

timing and control unit.

2. Power Supply: Powered from panelboard, sized to provide control power for operation of remotely operated circuit breakers, controller, bus system, control-voltage inputs, and field-installed sensors.
3. Integral keypad and digital-display front panel for local setup, including the following:

    a. Log and display remotely operated breaker on-time.
    b. Provision to accept downloadable firmware so that latest features may be added in future without replacing module.

4. Nonvolatile memory must retain all setup configurations. After a power failure, controller must automatically reboot and return to normal system operation.
5. Ethernet Communications: Comply with [**ASHRAE 135**][**ISO/IEC 14908-1**][**"MODBUS Application Protocol Specification"**]<**Insert network protocol**> protocols.

    a. Each input connected to controller must control any remotely operated breaker in any other networked electronically operated, circuit-breaker panelboard.
    b. A schedule programmed at one controller must be able to control any remotely operated breaker in any other networked panelboard.

6. Time Synchronization: Timing unit must be updated not less than every <**Insert number**> hour(s) with network time server.
7. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard Web browser.

    a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
    b. Separate Web page, showing status of each main and slave electronically operated, circuit-breaker panelboards with arrangement of breakers on page matching physical appearance of panel. Status must include breaker nametags, pole configuration, location in panel, actual contact state (on-off/tripped/manual), and breaker on-time.
    c. Panel summary showing master and slave panels connected to controller.
    d. Controller diagnostic information.
    e. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens must also allow direct breaker control and zone overrides.

8. Alarm and E-mail Notification: Automatically initiate alarms based on preconfigured conditions listed below and routing alarm alerts as set at control panel.

    a. General Alarms: Power loss, non-responding breakers, loss and restoration of sub-net communications, loss and restoration of serial port communications, loss and restoration of DDC system for HVAC commands.
    b. Specific Alarms: Input status, zone status, breaker status on-time (zero to 99999 hours).
    c. E-mail Notification: Automatically route e-mail messages to five individual e-mail addresses. Within body text of e-mail, include a link that will automatically redirect user to associated panels' status Web page.

B. Timing Unit:

1. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
2. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
3. [**16**]<**Insert number**> independent schedules, each having [**24**]<**Insert number**> time periods.
4. Schedule periods settable to the minute.
5. Day of week, day of month, day of year with one-time or repeating capability.

6. [**32**]<**Insert number**> special date periods.

C. With [**eight**][**16**]<**Insert number**> inputs, each configurable to the following parameters:

1. Normally open, normally closed, two-wire maintained toggle, two-wire momentary toggle, two-wire momentary on, two-wire momentary off, or three-wire momentary operation.
2. On and off-delay timers for local override operation, adjustable from five minutes to 12 hours. Local override must be by field-installed, two-wire momentary toggle switch.

2.7 SLAVE PANEL CONTROLLERS

A. Slave panels must contain necessary busses and network hardware to allow connection of sub-net wiring between panels, with programming at main panel controller. Programmable timing unit, Web server, alarm and e-mail notification, and Ethernet connection to control network is not required provided all of these functions are available for slave panel from main panel controller.

B. Sub-net wiring connections must allow connection of wiring to a terminal that can be removed from panel without interrupting communications to other panels.

C. Slave panels must contain a nameplate label attached to deadfront trim indicating panel designation, panel network address, and panel designation of associated master panel.

2.8 CONTROL NETWORK

A. Panel Controllers: Networked with other [**electronically operated, circuit-breaker panel controllers**][**DDC system for HVAC controllers**] in a peer-to-peer configuration using Ethernet [**10Base-T**][**100Base-T**] network.

B. Protocol: Controllers must support serial MS/TP and Ethernet IP communications, and must be able to communicate directly via DDC system for HVAC TIA-485 serial networks and Ethernet 10Base-T networks as a native device.

2.9 MANUAL SWITCHES AND COVER PLATES

A. Keypads: Programmable, designed to control functions associated with equipment of this Section. Units must be able to control any system output device.

B. Push-Button Switches: Modular, momentary-contact, control-voltage type.

1. Match color specified in Section 262726 "Wiring Devices."
2. Integral green [**digital-display**][**neon**] pilot light to indicate when circuit is on.
3. Internal white [**digital-display**][**neon**] locator light to illuminate when circuit is off.

C. Manual, Maintained Contact, Line-Voltage or Control-Voltage Switch: Comply with Section 262726 "Wiring Devices."

D. Cover Plates: Single and multigang cover plates as specified in Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Legend: Engraved or permanently silk-screened on cover plate where indicated. Use designations indicated on Drawings.

2.10 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 and Class 3 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 18**][**No. 22**][**No. 24**] AWG. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 14**][**No. 16**][**No. 18**] AWG. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

D. Twisted-Pair Data Cable:

1. [**Category 5e**][**Category 6**][**Category 6a**]. Comply with requirements for twisted pair cabling in Section 260523 "Control-Voltage Electrical Power Cables."
2. [**Category 5e**][**Category 6**][**Category 6a**]. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to [**NECA 407**][**NEMA PB 1.1**].

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING

A. Wiring Method:

1. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
2. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
c. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 INSTALLATION OF PANELBOARDS

A. Install panelboards and accessories according to [**NECA 407**][**NEMA PB 1.1**].

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Mounting Height: [**90 inch (2286 mm)**]<**Insert dimension**> to top of trim above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install filler plates in unused spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each circuit; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are unacceptable.

D. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Nonconforming Work:

1. Panelboard will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's instructions.
2. Confirm correct communication wiring, initiate communications between panels, and program control system according to approved time-of-day schedules and input override assignments.
3. <**Insert startup steps if any**>.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and

access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION 26 24 16 00A

SECTION 26 24 19 00 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components:

1. Automatic power transfer.
2. Feeder-tap units.
3. Measurement and control.
4. Auxiliary devices.
5. Panelboards.
6. Transformers.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCC: Motor-control center.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor-circuit protector.

E. OCPD: Overcurrent protective device.

F. PID: Control action; proportional plus integral plus derivative.

G. PT: Potential transformer.

H. SPD: Surge protective device.

I. SCR: Silicon-controlled rectifier.

J. VFC: Variable-frequency controller.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.

B. Sustainable Design Submittals:

1. Product Data: For continuous metering equipment for energy consumption.
2. Product Data: For continuous metering equipment for energy consumption.
3. Product Data: For continuous metering equipment for energy consumption.
4. Product Data: For continuous metering equipment for energy consumption.
5. Product Data: For continuous metering equipment for energy consumption.

C. Shop Drawings: For each MCC, manufacturer's [**approval**][**custom**][**and**][**production**] drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
g. Specified optional features and accessories.
h. <**Insert required information**>.

2. Schematic[**and Connection**] Wiring Diagrams: For power, signal, and control wiring for each installed controller.
3. Nameplate legends.
4. Vertical and horizontal bus capacities.
5. Features, characteristics, ratings, and factory settings of each installed unit.
6. <**Insert required information**>.

1.4 INFORMATIONAL SUBMITTALS

A. Standard Drawings: For each MCC, as defined in UL 845.

B. Production Drawings: For each MCC, as defined in UL 845.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Seismic Qualification Data: Certificates, for MCCs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their

installation requirements.

F. Product Certificates: For each MCC.

G. Source quality-control reports.

H. Field quality-control reports.

I. Load-Current and Overload Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

J. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

K. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
2. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications [**and field-assigned wiring identification**]incorporated during construction by manufacturer, Contractor, or both.
3. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
4. Manufacturer's written instructions for setting field-adjustable overload relays.
5. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
6. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
7. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Control Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**two**]<**Insert number**> of each size and type.
3. Indicating Lights: [**Two**]<**Insert number**> of each type and color installed.
4. Auxiliary Contacts: Furnish [**one**]<**Insert number**> spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish [**three**]<**Insert number**> spares for each size and type of magnetic contactor installed.
6. <**Insert extra materials**>.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.

D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.

B. Handle MCCs according to the following:

1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; [**install temporary electric heating, with at least 250 W per vertical section**][**connect factory-installed space heaters to temporary electrical service**].

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace [**MCC**][**and**][**SPD**]<**Insert devices**> that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MOTOR-CONTROL CENTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Rockwell Automation, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]

6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Eaton**]
3. [**Rockwell Automation, Inc.**]
4. [**Siemens Industry, Inc., Energy Management Division**]
5. [**Square D; Schneider Electric USA**]
6. <**Insert manufacturer's name**>

2.2 SYSTEM DESCRIPTION

A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.

B. Ambient Environment Ratings:

1. Ambient Temperature Rating: Not less than **0 deg F (minus 18 deg C)** and not exceeding **104 deg F (40 deg C)**, with an average value not exceeding **95 deg F (35 deg C)** over a 24-hour period.
2. Ambient Storage Temperature Rating: Not less than **minus 4 deg F (minus 20 deg C)** and not exceeding **140 deg F (60 deg C)**
3. Humidity Rating: Less than 95 percent (noncondensing).
4. Altitude Rating: Not exceeding **6600 feet (2000 m)**, or **3300 feet (1000 m)** if MCC includes solid-state devices.
5. <**Insert unusual service condition**>.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified[**and the system will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**][**1.0**].
3. Component Amplification Factor: 2.5.
4. Component Response Modification Factor: 6.0.

B. Capacities and Characteristics:

1. MCC Enclosure and Assembly:

a. Nominal System Voltage: [**277**][**277/480**][**600**]<**Insert number(s)**>-V ac.
b. Service Equipment Rated: [**Yes**][**No**].
c. Enclosure: NEMA 250, Type <**Insert number or number and a letter**>.

2. Integrated Short-Circuit Rating for MCC:

a. Combination series rated; <**Insert number**> kA.
b. Fully rated; <**Insert number**> kA.

3. Integrated Short-Circuit Rating for Each Unit:

a. Combination series rated; <**Insert number**> kA.
b. Fully rated; <**Insert number**> kA.

4. Wiring Class: <**Insert numbers and letters**>.
5. Bus:

a. Horizontal Bus: <**Insert number**> kA.
b. Neutral Bus: [**None**][**50 percent**][**Full size**][**150 percent**]<**Insert percentage**>.

6. Main Disconnect Device:

a. Main Disconnect: [**MCCB, UL 489,**][**Fusible switch, UL 98,**] three pole, <**Insert number**> A.[**Manually operated, electrically tripped.**]
b. SPD: UL 1449, [**Type 1**][**Type 2**].
c. Optional Features: <**Insert items**>.

7. Automatic Power Transfer: Electrically operated MCCBs, three pole, <**Insert number**> A.
8. Magnetic Controllers:

a. Tag Number: <**Insert numbers and letters**>, <**Insert description**>, <**Insert number**> hp, <**Insert number**> full-load A.

1) Classification by Starting Method: <**Insert text**>.
2) Controller Size: <**Insert number or numbers and letters**> complying with NEMA ICS 2.
3) Optional Features: <**Insert items**>.

9. Reduced-Voltage Solid-State Controllers:

a. Tag Number: <**Insert numbers and letters**>, <**Insert description**>, <**Insert number**> hp, <**Insert number**> full-load A.

1) Starting Configuration: <**Insert text**>.
2) Starting Mode: <**Insert text**>.
3) Stopping Mode: <**Insert text**>.
4) Controller Size: <**Insert number or numbers and letters**> complying with NEMA ICS 2.
5) Bypass Contactor: Comply with NEMA ICS 2.
6) Acceleration Control: <**Insert number**>.
7) Overload Relays: [**Melting alloy**][**Bimetallic**][**Solid state**]. Class [**10**][**20**][**30**].
8) Isolated Overload Alarm Contact: [**NC**][**NO**].
9) Optional Features: <**Insert items**>.

10. VFCs:

a. Tag Number: <**Insert numbers and letters**>, <**Insert description**>, <**Insert number**> hp, <**Insert number**> full-load A.

1) Bypass Mode: [**Manual**][**Field selectable, manual or automatic**].
2) Bypass Style: [**Two**][**Three**] contactor style.

3) Bypass Contactor Classification: [**Full-voltage (across-the-line)**][**Reduced-voltage autotransformer, open transition**][**Reduced-voltage autotransformer, closed transition**]<**Insert type**>.
4) Overload Relays: [**Melting alloy**][**Bimetallic**][**Solid state**]. Class [**10**][**20**][**30**].
5) Isolated Overload Alarm Contact: [**NC**][**NO**].
6) Optional Features: <**Insert items**>.

11. Controller-Mounted Auxiliary Devices:

a. Push Buttons and Selector Switches: [**Heavy**][**Standard**]-duty, [**oiltight**] type.
b. <**Insert devices**>.
c. Feeder Tap Units: Main Disconnect: [**MCCB, UL 489,**][**Fusible switch, UL 98,**] three pole, <**Insert number**> A.[**Manually operated, electrically tripped.**]

12. Panelboards: Tag Number <**Insert designation**>.

a. Mains: [**MCCB**][**Main lugs only**], <**Insert number**> phase, <**Insert number**> V, <**Insert number**> A.
b. [**Plug-in**][**Bolt-on**] circuit breakers.

13. Transformer(s): Tag Number <**Insert designation**>, <**Insert number**> kVA, <**Insert number**> V primary, <**Insert number**> V secondary.

a. Primary Circuit Breaker: MCCB, <**Insert number**> A.

14. Transfer Switch: Tag Number <**Insert designation**>, <**Insert number**> pole, <**Insert number**> A.

2.4 MOTOR-CONTROL CENTER ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, [**Type 1**][**Type 1A**][**Type 2**][**Type 12**] unless otherwise indicated to comply with environmental conditions at installed location.

B. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: [**Thermostats to maintain temperature of each section above expected dew point**][**Manual switching of branch-circuit protective device**].
2. Space-Heater Power Source: [**Transformer, factory installed in MCC**][**120-V external branch circuit**].

C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's [**standard gray**][**custom color**] finish over a rust-inhibiting primer on treated metal surface.

D. Outdoor Enclosures: Type 3R, [**non-walk-in aisle**][**with interior-lighted walk-in aisle**].

1. Finish: Factory-applied finish in manufacturer's [**standard**][**custom**] color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: [**Flat**][**Downward, rearward sloping**] roof; [**bolt-on rear covers**][**rear hinged doors**] for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of [**30 inches (762 mm)**]<**Insert dimension**>; opening outwards; with panic hardware and provisions for [**padlocking**][**cylinder lock**].
4. Accessories: Fluorescent luminaires, ceiling mounted; wired to a three-way light switch at each

end of aisle; GFCI duplex receptacle; emergency battery pack luminaire installed on wall of aisle midway between personnel doors.

5. Walk-in Aisle Heating and Ventilating:

    a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of [**40 deg F (5 deg C)**]<**Insert temperature**> with outside design temperature of [**plus 23 deg F (minus 5 deg C)**]<**Insert temperature**>.
    b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of [**100 deg F (38 deg C)**]<**Insert temperature**> with outside design temperature of [**104 deg F (40 deg C)**]<**Insert temperature**>.
    c. Ventilating openings[**complete with replaceable fiberglass air filters**].
    d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a CPT within the switchboard. Supply voltage shall be [**120**][**120/240**][**120/208**]-V ac.
7. Power for space heaters, ventilation, lighting, and receptacle supplied from a remote source.

2.5 ASSEMBLY

A. Structure:

1. Comply with UL requirements for service entrance equipment.
2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
3. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.
4. Pull Boxes:

    a. Include provisions for ventilation to maintain temperature in pull box within same limits as the MCC.
    b. Set the box back from front to clear circuit-breaker removal mechanism.
    c. Covers: Removable covers forming top, front, and sides.
    d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
    e. Cable Supports: Arranged to facilitate cabling and adequate to support cables, including supports for future cables.
    f. When equipped with barriers, supply with access to check bus bolt tightness.

B. Compartments: Modular; individual [**lift-off**]doors with concealed hinges and quick-captive screw fasteners.

1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

C. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC.

D. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and PTs or potential taps as required by utility company. If separate vertical section is

required for utility metering, match and align with basic MCC. Install service entrance label and applicable service entrance features. Comply with requirements in Section 262713 "Electricity Metering."

E. Owner's Metering Compartment: A separate customer metering compartment and section with front hinged door, metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.[**Include PTs having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.**]

F. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

G. Wiring Spaces:

1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. Horizontal wireways in [**bottom**][**and**][**top**] of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

H. Provisions for Future:

1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

I. Integrated Short-Circuit Rating:

1. Short-Circuit Current Rating for Each Unit: [**Combination series rated**][**Fully rated**]; [**22**][**42**][**65**][**100**]<**Insert number**> kA.
2. Short-Circuit Current Rating of MCC: [**Combination series rated**][**Fully rated**] with its main overcurrent device; [**22**][**42**][**65**][**100**]<**Insert number**> kA.

J. Control Power:

1. 120-V ac, supplied centrally [**from a CPT**][**from a remote branch circuit**].
2. [**24**][**120**]<**Insert number**>-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
3. Control Circuits: 24-V dc, supplied centrally from two redundant, automatically switched power supplies.
4. CPT Spare Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

K. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Wiring Class:

a. NEMA ICS 18, [**Class I**][**Class I-S**], [**Type A**][**Type B, for starters larger than Size 3**][**Type B-D, for starters Size 3 and smaller**][**Type B-T, for starters Size 3 and smaller**][**Type C**].
b. NEMA ICS 18, [**Class II**][**Class II-S**], [**Type B, for starters larger than Size 3**][**Type B-D, for starters Size 3 and smaller**][**Type B-T, for starters Size 3 and smaller**][**Type C**].

2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

L. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions[**from both ends**].
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase- and Neutral-Bus Material:

    a. Hard-drawn copper of 98 percent minimum conductivity or [**silver**][**tin**]-plated alloy, with [**mechanical**][**compression**] connectors for outgoing conductors.
    b. Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy, with [**mechanical**][**compression**] connectors for outgoing conductors.

4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size **1/4-by-2 inches (6 by 50 mm)**. Equip with [**mechanical**][**compression**] connectors for outgoing conductors.
5. Neutral Disconnect Link: Bolted, uninsulated, **1/4-by-2-inch (6-by-50-mm)** copper bus, arranged to connect neutral bus to ground bus.
6. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Insulation temperature rating shall not be less than 105 deg C.

2.6 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

    a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
    b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
    c. Time-current adjustments to achieve protective-device coordination as follows:

        1) Adjustable long-time delay.
        2) Adjustable short-time setting and delay to shape the time-current curve.
        3) Adjustable instantaneous setting.
        4) Individually adjustable ground-fault setting and time delay.

    d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.[**Provide one test set for testing the installed circuit breakers 225-A frame and higher.**]
    e. Built-in digital ammeter display, showing load current and tripping cause.

3. Switch operator power shall be from control power specified in "Assembly" Article.

B. MCCB (1600 to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be indicated by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
b. LED indicators or display, with manual reset, to show reasons of automatic trip.
c. Display panel to indicate the status of the system circuitry, or give fault location based on automatic diagnosis.
d. Trip the circuit breaker when closing on a fault.
e. Time-current adjustments to achieve protective-device coordination as follows:

1) Adjustable long-delay pickup and time.
2) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
3) Adjustable instantaneous pickup.
4) Individually adjustable ground-fault pickup and time, with [**I-squared-t setting**][**ground alarm**].

f. One test kit to test each trip function.
g. Battery backup for informational displays after automatic trip, with battery status indicator.

3. Switch operator power shall be from control power specified in "Assembly" Article.

C. MCC Main Disconnect Device: Fusible switch; fixed-mounted, manually operated, [**electrically tripped,**]quick-make, quick-break switch. Comply with UL 98.

1. Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2. Fuse clips and fuses.
3. Electrically tripped switches shall include the following:

a. Shunt trip.
b. Ground-fault protection, with adjustable time delay and test panel.
c. Single-phase protection, tripping the switch on loss of a source phase.
d. Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.
e. Switch operator power shall be from control power specified in "Assembly" Article.

D. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD [**Type 1**][**Type 2**].

2.7 AUTOMATIC POWER TRANSFER

A. Two-Breaker Transfer Control:

1. Transfer control, using electrically operated MCCBs, for an MCC supplied from two normally energized low-voltage power sources, designated "normal" and "standby." The circuit breakers connecting the two power sources to the load bus shall be controlled by a microprocessor-based automatic transfer control. Power for the transfer control shall be from the voltage-sensing transformers.

2. MCCBs (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

    a. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be indicated by the position of the handle, and manual push-to-trip push button.
    b. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

        1) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
        2) Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
        3) Time-current adjustments to achieve protective-device coordination as follows:

            a) Adjustable long-time delay.
            b) Adjustable short-time setting and delay to shape the time-current curve.
            c) Adjustable instantaneous setting.
            d) Individually adjustable ground-fault setting and time delay.

        4) Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.[**Provide one test set for testing the installed circuit breakers 225-A frame and higher.**]
        5) Built-in digital ammeter display, showing load current and tripping cause.

3. In the automatic mode, the load bus is connected to the normal power source. When the normal source fails, the control shall automatically open the normal power source and close the standby source circuit breaker.
4. Sequence of Operation:

    a. The default operation shall be with the normal source main breaker closed and standby main breaker open. On detection of an undervoltage to the line side of the normal main breaker and after a field-adjustable time delay, the main breaker shall open and, after an additional field-adjustable time delay, the standby breaker shall close and restore power to the facility.
    b. On restoration of voltage to the line side of the normal main breaker and after a field-adjustable time delay, the standby main breaker shall open and, after a field-adjustable time delay, the normal main breaker shall close.

5. Field-Adjustable Transfer Parameters:

    a. Delay the transfer from the normal power source to the standby power source and from the standby power source to the normal source. The time delay is to allow the load voltage to decay before reconnecting to another power source. Delay range is zero seconds to 30 minutes.
    b. Delay the initiation of the transfer sequence. The time delay is recommended to override a momentary power outage or voltage fluctuation. Delay range is zero to 120 seconds.
    c. Delay the transfer from the standby power source to the normal power source. Delay range is zero seconds to 30 minutes.
    d. A relay with contact that changes state when the power is available on the normal source, and a relay with contact that changes state when the power is available on the standby source.

6. Controls and Indicators: In addition to the delay setting controls, include the following:

a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers trip due to overcurrent or ground-fault.
b. Three-position selector switch to select the normal source: Source 1, Source 2, or none.
c. Transfer-control automatic and manual selector.

1) Interlock shall prevent paralleling of the two power sources in manual mode.

d. Open-close control switch for manual electrical operation of each controlled circuit breaker.
e. Selector to place control into programming mode.
f. Circuit breaker control switch for each of the normal and standby source breakers, providing open and close operation.
g. Push button to initiate manual retransfer to the normal source when the transfer controller is in the automatic mode.
h. Meters and display to show the following:

1) Voltage and frequency of both sources.
2) A multiline display showing the following:

a) Set points of timers, and voltage pickup and dropout set points.
b) Date, time, and reason for minimum of the last 10 transfers. The display may show the information for one transfer at a time using a scrolling control, with the others held in memory.
c) When the control system is in the transferring process, the display shall show delay countdown in seconds.

i. LED indicators to show the following:

1) Normal source available.
2) Standby source available.
3) Normal source connected.
4) Standby source connected.
5) Load bus energized.

7. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
8. Voltage Sensing Relays: Microprocessor-based, IEEE device number 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

2.8 MAGNETIC CONTROLLERS

A. Controller Units: Combination controllers.

B. Disconnects:

1. Fusible Switch:

a. UL 98 and NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate [**UL 248-8 Class J**][**UL 248-10 Class L**]<**Insert class**> fuses.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary Contacts: [**NC**][**NO**], arranged to activate before switch blades open.

2. MCP:

a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with

motor locked-rotor amperes.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
d. [**NC**][**NO**] alarm contact that operates only when MCP has tripped.
e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB:

a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
e. [**NC**][**NO**] alarm contact that operates only when MCCB has tripped.

4. Molded-Case Switch:

a. UL 489, with in-line fuse block for [**UL 248-8 Class J**][**UL 248-10 Class L**] power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
d. [**NC**][**NO**] alarm contact that operates only when molded-case switch has tripped.

C. Controllers: Comply with UL 508.

1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

a. Classification: [**Nonreversing**][**and**][**reversing**]<**Insert classification**>.

2. Reduced-Voltage Magnetic Controllers: Electrically held, NEMA ICS 2, general purpose, Class A; [**closed**][**open**] transition; adjustable time delay on transition. [**Electrically**][**Mechanically**] held.

a. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
b. Part-Winding Controller: Separate START and RUN contactors, with separate overload relays for starting and running sequences.
c. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; one RUN and two START contactors.

3. Multispeed Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

a. Classification, Nonreversing: [**Consequent pole**][**Two winding**].

1) Two speed, with compelling relays to ensure that motor will start only at low speed.
2) Timer Relays:

a) Accelerating, for properly timed acceleration through speeds lower than that selected.
b) Decelerating, for automatically timed deceleration through each speed.

b. Classification, Reversing: [**Consequent pole**][**Two winding**].

1) Two speed, with compelling relay to ensure that motor will start only at low speed.
2) Timer Relays:

a) Accelerating, for properly timed acceleration through speeds lower than that selected.
b) Decelerating, for automatically timed deceleration through each speed.

c. Antiplugging Relays: Time delay when transferring from FORWARD to REVERSE and back.

D. Overload Relays:

1. Melting-Alloy Overload Relays:

a. Inverse-time-current characteristic.
b. [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2. Bimetallic Overload Relays:

a. Inverse-time-current characteristic.
b. [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Ambient compensated.
e. Automatic resetting.

3. Solid-State Overload Relays:

a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.
c. [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
d. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
e. Analog communication module.

4. [**NC**][**NO**] isolated overload alarm contact.
5. External overload reset push button.

2.9 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

A. Controller Units: An integrated unit with disconnects, power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relays. Comply with UL 508.

1. Suitable for use with NEMA MG 1 Design B, polyphase induction motors.
2. <**Insert special applications**>.

B. Disconnects:

1. Fusible Switch:

    a. UL 98 and NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate [**UL 248-8 Class J**][**UL 248-10 Class L**]<**Insert class**> fuses.
    b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    c. Auxiliary Contacts: [**NC**][**NO**], arranged to activate before switch blades open.

2. MCP:

    a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    d. [**NC**][**NO**] alarm contact that operates only when MCP has tripped.
    e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB:

    a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    e. [**NC**][**NO**] alarm contact that operates only when MCCB has tripped.

4. Molded-Case Switch:

    a. UL 489, with in-line fuse block for [**UL 248-8 Class J**][**UL 248-10 Class L**] power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
    b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
    d. [**NC**][**NO**] alarm contact that operates only when molded-case switch has tripped.

C. Configuration: [**Standard**][**Severe**] duty; [**nonreversible**][**reversible**].

D. Starting Mode: [**Voltage ramping**][**Current limit**][**Torque control**][**Torque control with voltage boost**][**; field selectable**].

E. Stopping Mode: [**Coast to stop**][**Adjustable torque deceleration**][**Adjustable braking**][**; field selectable**].

F. Bypass Controller: Operates automatically to bypass the SCRs when the motor has reached rated speed and full voltage is applied to motor. Solid-state controller protective features shall remain active when the bypass relay is in the bypass mode.

1. Bypass Contactor: [**Manufacturer's standard product**][**or**][**NEMA ICS 2, general-purpose, Class A contactor, rated to start the load across the line**][**, as indicated on Drawings**].
2. Bypass Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating.

G. Acceleration Control: Adjustable, using voltage or current ramp, and adjustable starting torque control with up to [**400**]<**Insert number**> percent current limitation for 20 seconds.

H. SCR Bridge: At least two SCRs per phase, for stable and smooth acceleration [**with**][**without**] external feedback from the motor or driven equipment.

I. Keypad: Front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:

1. Adjusting motor full-load amperes, as a percentage of the controller's rating.
2. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
3. Adjusting linear acceleration and deceleration ramps, in seconds.
4. Setting initial torque, as a percentage of the nominal motor torque.
5. Adjusting torque limit, as a percentage of the nominal motor torque.
6. Adjusting maximum start time, in seconds.
7. Adjusting voltage boost, as a percentage of the nominal supply voltage.
8. Selecting stopping mode and adjusting parameters.
9. Selecting motor thermal-overload protection class between 5 and 30.
10. Activating and deactivating protection modes.
11. Selecting or activating communications modes.
12. <**Insert function**>.

J. Digital Display: Front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:

1. Controller Condition: Ready, starting, running, stopping.
2. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
3. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
4. <**Insert items**>.

K. Controller Diagnostics and Protection:

1. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor overload alarm and trip; settings selectable via the keypad.
2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency excursions to over- or under-normal. Accomplish protection by the following:

    a. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component, or when the motor is stopped.
    b. Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
    c. <**Insert items**>.

L. Remote Output Features:

1. All outputs prewired to terminal blocks.
2. Form C status contacts that change state when controller is running.
3. Form C alarm contacts that change state when a fault condition occurs.
4. <**Insert items**>.

M. Overload Relays:

1. Melting-Alloy Overload Relays:

    a. Inverse-time-current characteristic.
    b. [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2. Bimetallic Overload Relays:

    a. Inverse-time-current characteristic.
    b. [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    d. Ambient compensated.
    e. Automatic resetting.

3. Solid-State Overload Relays:

    a. Switch or dial selectable for motor-running overload protection.
    b. Sensors in each phase.
    c. [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    d. UL 1053, Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    e. Analog communication module.

N. Optional Features:

1. Analog output for field-selectable assignment of motor operating characteristics; [**0- to 10-V dc**][**4- to 20-mA dc**].
2. [**Two**]<**Insert number**> additional field-assignable Form C contacts for alarm outputs.
3. Full-voltage/BYPASS selector switch. Power contacts shall be totally enclosed, double break, made of silver-cadmium oxide, and assembled to allow inspection and replacement without disturbing line or load wiring.

2.10 VFC

A. Controller Units: Combination controllers, consisting of variable-frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 508C, and [**UL 508E**]<**Insert standard**>.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
4. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.

B. Disconnects:

1. Fusible Switch:

    a. UL 98 and NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate [**UL 248-8 Class J**][**UL 248-10 Class L**]<**Insert class**> fuses.
    b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    c. Auxiliary Contacts: [**NC**][**NO**], arranged to activate before switch blades open.

2. MCP:

    a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    d. [**NC**][**NO**] alarm contact that operates only when MCP has tripped.
    e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB:

    a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    e. [**NC**][**NO**] alarm contact that operates only when MCCB has tripped.

4. Molded-Case Switch:

    a. UL 489, with in-line fuse block for [**UL 248-8 Class J**][**UL 248-10 Class L**] power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
    b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
    d. [**NC**][**NO**] alarm contact that operates only when molded-case switch has tripped.

5. Disconnect Rating:

    a. Not less than 115 percent of VFC input current rating.
    b. Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

6. Auxiliary Contacts: [**NC**][**NO**], arranged to activate before switch blades open.
7. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
8. [**NC**][**NO**] alarm contact that operates only when circuit breaker has tripped.

C. Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus [**10**][**15**] percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding [**3**][**5**] percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: [**96**][**97**]<**Insert number**> percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: [**96**][**98**]<**Insert number**> percent under any load or speed condition.

6. Overload Capability:

    a. For variable-torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
    b. For constant-torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
8. Speed Regulation: Plus or minus [**5**][**10**] percent.
9. Output Carrier Frequency: Field selectable.
10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
11. Internal Adjustability Capabilities:

    a. Minimum Speed: 5 to 25 percent of maximum rpm.
    b. Maximum Speed: 80 to 100 percent of maximum rpm.
    c. Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
    d. Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
    e. Current Limit: 30 to a minimum of 150 percent of maximum rating.
    f. <**Insert adjustment and parameters**>.

12. Self-Protection and Reliability Features:

    a. Input transient protection by means of SPDs for three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
    b. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
    c. Under- and overvoltage trips.
    d. Inverter overcurrent trips.
    e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
    f. Critical frequency rejection, with [**three**]<**Insert number**> selectable, adjustable deadbands.
    g. Instantaneous line-to-line and line-to-ground overcurrent trips.
    h. Loss-of-phase protection.
    i. Reverse-phase protection.
    j. Short-circuit protection.
    k. Motor overtemperature fault.
    l. <**Insert additional protection or reliability feature**>.

13. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
14. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

D. Operator Station:

1. Inverter Logic: Microprocessor based, [**16**][**32**] bit, isolated from all power circuits.
2. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
3. Panel-mounted, manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
b. Security Access: Electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

E. Displays:

1. Historical Logging Information and Displays:

a. Real-time clock with current time and date.
b. Running log of total power versus time.
c. Total run time.
d. Fault log, maintaining last [**four**]<**Insert number**> faults with time and date stamp for each.
e. <**Insert information or display**>.

2. Indicating Devices: Digital display[**and additional readout devices as required,**] mounted flush in VFC door and connected to display VFC parameters including the following:

a. Output frequency (Hz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percentage).
f. Fault or alarming status (code).
g. PID feedback signal (percentage).
h. DC-link voltage (V dc).
i. Set-point frequency (Hz).
j. Motor output voltage (V ac).
k. <**Insert parameter**>.

F. Bypass Systems:

1. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes, and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
2. Manual Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
3. Field-Selectable Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
4. Two-Contactor Bypass Controller: Allows motor operation via the power converter or the bypass controller[**; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode**].

a. Bypass Contactor: Load-break, [**IEC**][**NEMA**]-rated contactor.
b. Output Isolating Contactor: Non-load-break, [**IEC**][**NEMA**]-rated contactor.
c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

5. Three-Contactor Bypass Controller: Allows motor operation via the power converter or the bypass controller[**; with input isolating switch and barrier**] arranged to isolate the power converter

input and output and permit safe testing[**and troubleshooting**] of the power converter, both energized and de-energized, while motor is operating in bypass mode.

a. Bypass Contactor: Load-break, [**IEC**][**NEMA**]-rated contactor.
b. Input and Output Isolating Contactors: Non-load-break, [**IEC**][**NEMA**]-rated contactors.
c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

6. Bypass Contactor Classification: [**Full-voltage (across-the-line)**][**Reduced-voltage autotransformer, open transition**][**Reduced-voltage autotransformer, closed transition**]<**Insert type**> type.
7. NORMAL/BYPASS selector switch.

a. HAND/OFF/AUTO selector switch.
b. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
2) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

8. Overload Relays: NEMA ICS 2.

a. Melting-Alloy Overload Relays:

1) Inverse-time-current characteristic.
2) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

b. Bimetallic Overload Relays:

1) Inverse-time-current characteristic.
2) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
4) Ambient compensated.
5) Automatic resetting.

c. Solid-State Overload Relays:

1) Switch or dial selectable for motor-running overload protection.
2) Sensors in each phase.
3) [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5) Analog communication module.

d. [**NC**][**NO**] isolated overload alarm contact.
e. External overload reset push button.

G. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

I. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

J. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from [**the firefighter's control station**][**smoke-control fan controller**]<**Insert location**>, the following password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
3. Forces VFC to transfer to bypass mode and operate motor at full speed.
4. Causes display of override mode on the VFC display.
5. Reset VFC to normal operation on removal of override signal [**automatically**][**manually**].

K. Communication Port: [**Ethernet**][**RS-232 port**][**USB 2.0 port**] or equivalent connection Capable of connecting a printer[**and a notebook computer**].

L. <**Insert feature**>.

2.11 CONTROLLER-MOUNTED AUXILIARY DEVICES

A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.

1. Push Buttons, Pilot Lights, and Selector Switches: [**Heavy**][**Standard**]-duty, [**oiltight**] type.

   a. Push Buttons: [**Covered**][**Lockable**][**Recessed**][**Shielded**][**Shrouded**][**Unguarded**] types; [**maintained**][**momentary**] contact unless otherwise indicated.
   b. Pilot Lights: [**LED**][**Resistor**][**Transformer**] types; <**Insert color(s)**>[**; push to test**].
   c. Selector Switches: [**Rotary**]<**Insert description**> type.

B. Elapsed-Time Meters: Heavy duty with digital readout in hours[**; nonresettable**][**; resettable**].

C. Meters: Panel type, **2-1/2-inch (64-mm)** minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having an off position.

D. Auxiliary Dry Contacts: [**NC**][**NO**][**Reversible NC/NO**].

E. Control Relays:

1. Time Delay: Auxiliary and adjustable [**pneumatic**][**solid-state**] time-delay relays.
2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.
3. <**Insert control device**>.

2.12 MEASUREMENT AND CONTROL DEVICES

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. PTs: IEEE C57.13; 120 V, 60 Hz, [**single**][**tapped**][**double**] secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; [**wound**][**bushing**][**bar or window**] type; [**single**][**double**] secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, for selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker and ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Listed or recognized by a nationally recognized testing laboratory.
2. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
3. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:

    a. Phase Currents, Each Phase: Plus or minus 1 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    d. Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
    e. Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.
    f. Power Factor: Plus or minus 2 percent.
    g. Frequency: Plus or minus 0.5 percent.
    h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
    j. Contact devices to operate remote impulse-totalizing demand meter.

4. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1. **4-inch (100-mm)** diameter or **6 inches (150 mm)** square, flush or semiflush, with antiparallax 250-degree scale and external zero adjustment.

1. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
2. Feeder Ammeters: **2-1/2-inch (64-mm)** minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for feeder circuits, unless otherwise indicated.

D. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and phase-to-neutral voltages where a neutral is included.
2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

E. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semiflush mounted case with matching cover.
12. Appropriate multiplier tag.

F. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with MCC watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording [**five**][**15**][**30**]<**Insert time**>-minute integrated demand of totalized system.

G. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

2.13 FEEDER TAP UNITS

A. MCCBs (to 1200 A): Fixed mounted, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Comply with UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

1. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I2t response.

3. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
4. With built-in digital ammeter and a digital display, showing tripping cause.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: [**One SPDT switch**][**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker

contacts.

8. Alarm Switch: One [**NC**][**NO**] contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with [**electronic**][**ground-fault**] trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Remote control for on, off, and reset operations.

B. Fusible Switches (to 600 A): Fixed-mounted, manually operated, [**electrically tripped,**]fusible, quick-make, quick-break switch with 200-kA interrupting and short-circuit current rating when fitted with UL 248-8 Class J fuses. Comply with UL 98.

1. Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2. Include fuse clips and fuses.
3. Electrically tripped switches shall include the following:

    a. Shunt trip.
    b. Ground-fault protection, with adjustable time delay and test panel.
    c. Single-phase protection, tripping the switch on loss of a source phase.
    d. Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.

2.14 PANELBOARDS

A. Comply with NEMA PB 1.

B. Branch OCPDs for Circuit-Breaker Frame Sizes 125 A and Smaller: [**Plug-in**][**Bolt-on**] circuit breakers.

C. Branch OCPDs for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

D. Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**][**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

E. Accessory Control Power Voltage: Integrally mounted, self-powered, <**Insert number**> [**Remote mounted and powered**].

2.15 TRANSFORMERS

A. Factory-assembled and -tested, air-cooled, two-winding, low-voltage dry-type transformers; with primary circuit breaker. Comply with NEMA ST 20.

B. Taps for Transformers Smaller Than 3 kVA: [**None**][**One 5 percent tap above normal full capacity**].

C. Taps for Transformers 7.5 to 24 kVA: [**One 5 percent tap above and one 5 percent tap below normal full capacity**][**Two 5 percent taps below rated voltage**].

D. Taps for Transformers 25 kVA and Larger: [**Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity**][**Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity**].

E. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of

[**150**][**115**][**80**] deg C rise above 40 deg C ambient temperature.

F. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

2.16 TRANSFER SWITCHES

A. Factory-assembled and -tested, open-transition transfer switches. The transfer switch shall comply with UL 1008[**and be listed and labeled by a qualified testing agency**].

B. Comply with NEMA ST 20.

C. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

D. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

E. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

F. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41.1. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

G. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

H. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

I. Neutral Switching. Where four-pole switches are indicated, equip with [**neutral pole switched simultaneously with phase poles**][**overlapping neutral contacts**].

J. Neutral Terminal: Solid and rated the same as the neutral bus.

K. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall

have communication capability matched with remote device.

2.17 SOURCE QUALITY CONTROL

A. MCC Testing: Test and inspect MCCs according to requirements in [**NEMA ICS 18**]<**Insert standard**>.

B. VFC Testing: Test and inspect VFCs according to requirements in [**NEMA ICS 61800-2**]<**Insert standard**>.

1. Test each VFC while connected to [**its specified motor**][**a motor that is comparable to that for which the VFC is rated**].
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

C. MCCs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, <**Insert Project-specific conditions,**> and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.

B. Floor Mounting: Install MCCs on **4-inch (100-mm)** nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible switch.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

I. Install power factor correction capacitors. Connect to the [**line**][**load**] side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components.
2. Install required warning signs.
3. Label MCC and each cubicle with engraved nameplate.
4. Label each enclosure-mounted control and pilot device.
5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 INSTALLATION OF CONTROL WIRING

A. Install wiring between [**enclosed controllers**][**master terminal boards**] and remote devices [**and facility's BAS**][**and facility's central-control system**]. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533.13 "Conduits for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

F. MCCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.

2. <**Insert startup steps if any**>.

3.8 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.

B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify [**Architect**][**Construction Manager**][**Owner**] before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers at [**50**][**65**][**80**] percent.

E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

F. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

G. Set field-adjustable circuit-breaker trip ranges[**as specified in Section 260573.16 "Coordination Studies."**]

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers[**, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers**].

END OF SECTION 26 24 19 00

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Task	Specification	Specification Description
26 24 19 00	26 09 23 00	Electrical Power Monitoring
26 24 19 00	26 11 16 11	Secondary Unit Substations with Switchgear Secondary
26 24 19 00	26 27 33 00	Power Distribution Units

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SECTION 26 25 00 00 - LOW-VOLTAGE ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Enclosed bus assemblies.
2. Plug-in devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Shop Drawings: For each type of product.

1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
2. Show fittings, materials, fabrication, and installation methods for [**listed firestop barriers**][**and**][**weather barriers**].
3. Indicate required clearances, method of field assembly, and location and size of each field connection.
4. Detail connections to switchgear, switchboards, transformers, and panelboards.
5. Cable and conductor terminal sizes for bus and plug-in device terminations.
6. Wiring Diagrams: Power[**and signal**][**and control**][**, signal, and control**] wiring.

B. Delegated Design Submittal: For seismic-restraint details, signed and sealed by a qualified structural professional engineer.

1. Include design calculations for selecting seismic restraints.
2. Detail fabrication, including anchorages and attachments to structure and to supported equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Plug-in Units: [**10**]<**Insert number**> percent of amount installed[**for each size indicated**], but no fewer than <**Insert number**> unit(s).

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less."

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Source Limitations: Obtain enclosed bus assemblies[**and plug-in devices**] from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 857.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified electrical professional engineer to design enclosed bus assemblies, plug-in devices, and components.

2.3 ENCLOSED BUS ASSEMBLIES

A. Feeder-Bus Assemblies: Low-impedance bus assemblies in totally enclosed, nonventilated housing; single-bolt joints; ratings as indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**EAE USA**]
c. [**Eaton**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**EAE USA**]
c. [**Eaton**]

d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for feeder-bus assemblies with reinforcement strong enough to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems" when mounting provisions and attachments are anchored to building structure.
4. Electrical Characteristics:

   a. Voltage: [**120/208**][**240**][**480**][**277/480**] V.
   b. Phase: Three; [**3 wire**][**4 wire**].
   c. Percent of Neutral Capacity: [**50**][**100**][**200**]<**Insert value**>.

5. Short-Circuit Interrupting Rating:

   a. For Bus Amperage of 800: 85 symmetrical kAIC.
   b. For Bus Amperage of 1200: 100 symmetrical kAIC.
   c. For Bus Amperage of 1600: 125 symmetrical kAIC.
   d. For Bus Amperage of 2500: 150 symmetrical kAIC.
   e. For Bus Amperage of 5000: 200 symmetrical kAIC.

6. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
7. Bus Materials: Current-carrying [**copper**][**aluminum**] conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.
8. Voltage Drop:

   a. Measure voltage drop at 30 deg C ambient with bus thermally stabilized at full rated load.
   b. Three-phase, line-to-line voltage drop less than 3.1 V per **100 ft.** **(30.5 m)** at 40 percent power factor.

9. Ground: 50 percent capacity, [**integral with housing**][**internal bus bar of material matching bus material**][**isolated, internal bus bar of material matching bus material**].
10. Enclosure: [**Steel**][**Aluminum**], with manufacturer's standard finish.[**Weatherproof, sealed seams, drains, and removable closures.**]
11. Fittings and Accessories: Manufacturer's standard.
12. Firestop: Comply with UL 1479 firestop system, listed and labeled by an NRTL acceptable to authorities having jurisdiction for penetrations of fire-rated walls, ceilings, and floors.
13. Mounting: Arranged flat, edgewise, or vertically without derating. Rated for hanger spacing of up to **10 ft.** **(3 m)** for horizontally mounted runs and up to **16 ft.** **(5 m)** for vertically mounted runs.
14. Expansion Section: Manufacturer's standard expansion fitting for the provided busway with expansion capability to accommodate thermal expansion of bus and enclosure, and to accommodate movement across building expansion joints.

B. Plug-in Bus Assemblies: Low-impedance bus assemblies in totally enclosed, nonventilated housing; single-bolt joints; ratings as indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]

e. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Eaton**]
   c. [**Siemens Industry, Inc., Energy Management Division**]
   d. [**Square D; Schneider Electric USA**]
   e. **<Insert manufacturer's name>**

3. Electrical Characteristics:

   a. Voltage: [**120/208**][**240**][**480**][**277/480**] V.
   b. Phase: Three; [**3 wire**][**4 wire**].
   c. Percent of Neutral Capacity: [**100**][**200**]<**Insert value**>.

4. Short-Circuit Interrupting Rating:

   a. For Bus Amperage of 800: 85 symmetrical kAIC.
   b. For Bus Amperage of 1200: 100 symmetrical kAIC.
   c. For Bus Amperage of 1600: 125 symmetrical kAIC.
   d. For Bus Amperage of 2500: 150 symmetrical kAIC.
   e. For Bus Amperage of 5000: 200 symmetrical kAIC.

5. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
6. Bus Materials: Current-carrying [**copper**][**aluminum**] conductors, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.
7. Ground: 50 percent capacity, [**integral with housing**][**internal bus bar of material matching bus material**][**isolated, internal bus bar of material matching bus material**].
8. Enclosure: [**Steel**][**Aluminum**], with manufacturer's standard finish.
9. Plug-in Openings: **24 inch (600 mm)** on center on each side of bus, and hinged covers over unused openings. Plug-in openings must be finger-safe with covers open or closed.
10. Fittings and Accessories: Manufacturer's standard.
11. Firestop: Comply with UL 1479 firestop system, listed and labeled by an NRTL acceptable to authorities having jurisdiction for penetrations of fire-rated walls, ceilings, and floors.
12. Mounting: Arranged flat, edgewise, or vertically without derating. Rated for hanger spacing of up to **10 ft. (3 m)** for horizontally mounted runs and up to **16 ft. (5 m)** for vertically mounted runs.
13. Expansion Section: Manufacturer's standard expansion fitting for the provided busway with expansion capability to accommodate thermal expansion of bus and enclosure, and to accommodate movement across building expansion joints.

C. Joints:

1. Busway joints must use one high-strength steel bolt with Belleville washers.
2. Bolts must be torque indicating type and at ground potential.
3. Bolts must be two-headed design to indicate when proper torque has been applied and require only a standard long handle wrench to be properly activated.
4. Access must be required to only one side of the busway for tightening joint bolts.
5. Joint connection assemblies must be removable without disturbing adjacent busway lengths.
6. Joint connection assemblies that rely on the joint cover to provide ground continuity are unacceptable.

2.4 PLUG-IN DEVICES

A. Fusible Switches: NEMA KS 1, heavy duty; with [**R-type rejection**][**J-type**][**L-type**] fuse clips to accommodate specified fuses; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. Interlocked to prevent plug-in device insertion into or removal from bus with switch in closed position. See Section 262813 "Fuses" for fuses and fuse installation requirements.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**Siemens Industry, Inc., Energy Management Division**]
    c. [**Square D; Schneider Electric USA**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]
    b. [**Siemens Industry, Inc., Energy Management Division**]
    c. [**Square D; Schneider Electric USA**]
    d. <**Insert manufacturer's name**>

B. Molded-Case Circuit Breakers: UL 489; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. Interlocked to prevent plug-in device insertion into or removal from bus with switch in closed position.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Eaton**]
    c. [**NOARK Electric North America**]
    d. [**Siemens Industry, Inc., Energy Management Division**]
    e. [**Square D; Schneider Electric USA**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Eaton**]
    c. [**NOARK Electric North America**]
    d. [**Siemens Industry, Inc., Energy Management Division**]
    e. [**Square D; Schneider Electric USA**]
    f. <**Insert manufacturer's name**>

C. SPD: NEMA 250, Type 1 enclosure with NEMA KS 1, fusible, disconnect switch and external handle to isolate SPD from busway. SPD product and installation requirements are specified in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Advanced Protection Technologies Inc. (APT)**]
    c. [**ALLTEC LLC**]
    d. [**Eaton**]
    e. [**Emerson Electric Co., Automation Solutions**]
    f. [**LEA International**]
    g. [**Leviton Manufacturing Co., Inc.**]
    h. [**Mersen USA**]
    i. [**PowerLogics, Inc./PQ Protection**]
    j. [**Schneider Electric USA, Inc.**]
    k. [**Siemens Industry, Inc., Energy Management Division**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Advanced Protection Technologies Inc. (APT)**]
    c. [**ALLTEC LLC**]
    d. [**Eaton**]
    e. [**Emerson Electric Co., Automation Solutions**]
    f. [**LEA International**]
    g. [**Leviton Manufacturing Co., Inc.**]
    h. [**Mersen USA**]
    i. [**PowerLogics, Inc./PQ Protection**]
    j. [**Schneider Electric USA, Inc.**]
    k. [**Siemens Industry, Inc., Energy Management Division**]
    l. <**Insert manufacturer's name**>

D. Motor Controllers: NEMA ICS 2, Class A, full voltage, nonreversing, across the line unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**ABB, Motion Business**]
    c. [**Cerus Industrial, Inc.**]
    d. [**Eaton**]
    e. [**Rockwell Automation, Inc.**]
    f. [**Siemens Industry, Inc., Energy Management Division**]
    g. [**Square D; Schneider Electric USA**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**ABB, Motion Business**]
c. [**Cerus Industrial, Inc.**]
d. [**Eaton**]
e. [**Rockwell Automation, Inc.**]
f. [**Siemens Industry, Inc., Energy Management Division**]
g. [**Square D; Schneider Electric USA**]
h. <**Insert manufacturer's name**>

3. Control Circuit: 120 V; obtained from [**integral control power transformer**]<**Insert source of control power**> with a control power [**transformer**][**source**] of enough capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
4. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.

   a. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with [**R-type rejection**][**J-type**] fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1, as certified by an NRTL acceptable to authorities having jurisdiction. See Section 262813 "Fuses" for fuses and fuse installation requirements.
   b. Circuit-Breaker Disconnecting Means: UL 489, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

5. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, [**Class 10**][**Class 20**][**Class 30**] tripping characteristic. Overload relays must have heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
6. Adjustable Overload Relay: Dipswitch selected for motor running overload protection with NEMA ICS 2, [**Class 10**][**Class 20**][**Class 30**] tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Adjustable overload relays must have Class II ground-fault protection with start and run delays to prevent nuisance trip on starting.

E. Multispeed Magnetic Controllers: Match controller to motor type, application, and number of speeds.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]

f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Compelling relay ensures motor starts only at low speed.
4. Accelerating relay ensures properly timed acceleration through speeds lower than that selected.
5. Decelerating relay ensures automatically timed deceleration through each speed.

F. Accessories: Hookstick operator, adjustable to maximum extension of [**14 ft. (4.3 m)**]<**Insert dimension**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including luminaires, HVAC equipment, fire-suppression system, and partition assemblies.

B. Equipment Mounting:

1. Install enclosed bus assemblies on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete curbs around openings for vertical bus. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.

1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Section 260548.16 "Seismic Controls for Electrical Systems."
2. Design each fastener and support to carry **200 lb (90 kg)** or 4 times the weight of bus assembly, whichever is greater.
3. Support bus assembly to prevent twisting from eccentric loading.
4. Support bus assembly with not less than [**3/8 inch (10 mm)**]<**Insert dimension**> steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
5. Fasten supports securely to building structure according to Section 260529 "Hangers and Supports for Electrical Systems."
6. Bolts and nuts that are loosened for any reason after tightening to manufacturer's recommended torque setting must be discarded and replaced with new bolts and nuts.

D. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.

E. Construct rated firestop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Section 078413 "Penetration Firestopping."

F. Install weatherseal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Section 079200 "Joint Sealants" for materials and application.

G. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.

H. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.

I. Install bus-assembly, plug-in units. Support connecting conduit independent of plug-in unit.

3.2 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Terminate to transformer enclosures with matching bus assemblies according to Section 262200 "Low-Voltage Transformers."

D. Terminate to switchgear enclosures with matching bus assemblies according to Section 262300 "Low-Voltage Switchgear."

E. Terminate to switchboard enclosures with matching bus assemblies according to Section 262413 "Switchboards."

F. Terminate to panelboard enclosures with matching bus assemblies according to Section 262416 "Panelboards."

G. Terminate to motor-control centers enclosures with matching bus assemblies according to Section 262419 "Motor-Control Centers."

3.3 FIELD QUALITY CONTROL

A. Field tests must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify correct connection according to single-line diagram.
    e. Inspect bolted electrical connections for high resistance using one or more of the following methods:

        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
        3) Perform thermographic survey.

3. Electrical Tests:

a. Perform insulation resistance measurements through bolted connections and bus joints with low-resistance ohmmeter.
b. Perform insulation resistance tests of each busway, phase to phase, and phase to ground.
c. Perform a dielectric withstand voltage test on each busway, phase to ground with phases not under test grounded for one minute.
d. Measure resistance of assembled busway sections on insulated busway and compare values with adjacent phases.
e. Perform phasing test on each busway tie section energized by separate sources.
f. Verify operation of busway space heaters.

C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

E. Nonconforming Work:

1. Enclosed bus assemblies will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING

A. Set field-adjustable, circuit-breaker trip ranges[**and overload relay trip settings**] as indicated.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.6 PROTECTION

A. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 26 25 00 00

Task	Specification	Specification Description
26 25 13 00	26 25 00 00	Low-Voltage Enclosed Bus Assemblies
26 25 16 00	26 25 00 00	Low-Voltage Enclosed Bus Assemblies

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SECTION 26 27 13 00 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electricity meters.
2. Work to accommodate utility company revenue meters, and Owner's electricity meters used to manage electrical power system.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. KY or KYZ Pulse: Term used by metering industry to describe method of measuring consumption of electricity (kWh) that is based on relay opening and closing in response to rotation of disk in meter. Electronic meters generate pulses electronically.

1.3 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.

a. Comply with requirements of utility providing electrical power services.
b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of meter.
2. For metering infrastructure components.
3. For metering software.

B. Shop Drawings: For electricity-metering equipment.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control

wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.

4. Include series-combination rating data for modular meter centers with main disconnect device.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
6. Submit evidence that meters are compatible with connected monitoring and control devices and systems specified in [**Section 260913 "Electrical Power Monitoring and Control."**]<**Insert Section number and title.**>

    a. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
    b. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

C. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation of metering equipment.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed metering equipment performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that metering equipment performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with UL 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by utility company, complying with its requirements.

B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by Utility.

1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

D. Meter Sockets:

1. Comply with requirements of electrical-power utility company.
2. Steady-state and short-circuit current ratings must meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of main service [**terminal box with lugs only**][**disconnect device**], wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Comply with requirements of utility company for meter center.

   a. Comply with UL 67.

4. Housing: UL 50E, [**Type 1**][**Type 3R**][**Type 4X**] enclosure.
5. Meter Socket Rating: Coordinated with connected feeder circuit rating.
6. Minimum Short-Circuit Rating: [**22 000 A**][**42 000 A**][**65 000 A**][**100 000 A**]<**Insert amperes**> symmetrical at rated voltage.
7. Steady-state and short-circuit current ratings must have ratings that match connected circuit ratings.
8. Main Disconnect Device:

   a. Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers and having adjustable magnetic trip setting for circuit-breaker frame sizes of 250 A and larger. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Circuit breakers must be operable from outside enclosure to disconnect unit. Configure cover so it can be opened only when disconnect switch is open.
   b. Fusible switch, UL 98 Type GD, series-combination rated by fuse manufacturer to protect downstream feeder and branch circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Switch must be operable from outside enclosure to disconnect unit. Configure cover so that it can be opened only when disconnect switch is open.

9. Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect downstream circuit breakers and to house load centers and panelboards that have [**10 000 A**]<**Insert amperes**> interrupting capacity.

   a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems."
   b. Physical Protection: Tamper resistant, with hasp for padlock.

10. Surge Protection:

    a. Factory-installed in main disconnect, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
    b. Field-mounted external to main disconnect, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
    c. Factory-installed in main terminal box, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
    d. Field-mounted external to main terminal box, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

F. Arc-Flash Warning Labels:

1. Comply with requirements for "Arc-Flash Warning Labels" in Section 260573.19 "Arc-Flash Studies." Apply **3-1/2-by-5 inch (76-by-127 mm)** thermal transfer label of high-adhesion

polyester for each work location included in the analysis.

2. Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply **3-1/2-by-5 inch (76-by-127 mm)** thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels must be machine printed, with no field-applied markings.

    a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

        1) Location designation.
        2) Nominal voltage.
        3) Flash protection boundary.
        4) Hazard risk category.
        5) Incident energy.
        6) Working distance.
        7) Engineering report number, revision number, and issue date.

2.3 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Davidge Controls**]
3. [**E-Mon**]
4. [**Eaton**]
5. [**GE Power; General Electric Company**]
6. [**Leviton Manufacturing Co., Inc.**]
7. [**National Meter Industries**]
8. [**Sensus Metering Systems**]
9. [**Siemens Industry, Inc., Energy Management Division**]
10. [**Square D; Schneider Electric USA**]
11. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Davidge Controls**]
3. [**E-Mon**]
4. [**Eaton**]
5. [**GE Power; General Electric Company**]
6. [**Leviton Manufacturing Co., Inc.**]
7. [**National Meter Industries**]
8. [**Sensus Metering Systems**]
9. [**Siemens Industry, Inc., Energy Management Division**]
10. [**Square D; Schneider Electric USA**]
11. <**Insert manufacturer's name**>

D. General Requirements for Meters:

1. Comply with NEMA ANSI C12.1 and NEMA ANSI C12.20, [**0.1**][**0.2**][**0.5**] accuracy class.
2. Ambient Temperature: **Minus 22 deg F to plus 158 deg F (Minus 30 deg C to plus 70 deg C)**.
3. Humidity: Zero to 95 percent, noncondensing.
4. Capacities and Characteristics:

    a. Circuit: 120/240 V(ac), 100 A.
    b. Measure: kWh, onboard LED display.
    c. Remote-Reading Options: None.

5. Billing Meters Accuracy: [**0.2**][**0.5**][**1.0**] percent of reading, complying with NEMA ANSI C12.20.
6. Meter Certification: Certified by [**California Type Evaluation Program**]<**Insert agency**> as complying with [**4 CCR 4027, Article 2.2**]<**Insert state or Federal regulatory requirement**>.
7. Certify that meters comply with NEMA ANSI C12.20 requirements by laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). Laboratory must use test equipment that is certified annually and is traceable to NIST standards.
8. Enclosure: Supplied by meter manufacturer, UL 50E, [**Type 1**][**Type 3R**][**Type 4X**] minimum, with provisions for locking or sealing.
9. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
10. Onboard Nonvolatile Data Storage: kWh, until reset.
11. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: [**Split**][**and**][**solid**] core, complying with recommendation of meter manufacturer.

E. kWh Meter: Electronic [**single-phase**][**and**][**three-phase**] meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter must be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display:

    a. LCD with characters not less than **0.25 inch (6 mm)** high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in nonvolatile memory, until reset.
    b. Digital electromechanical counter, indicating accumulative kWh.

F. kWhd Meter: Electronic [**single-phase**][**and**][**three-phase**] meters, measuring electricity use and demand. Demand must be integrated over [**15-minute**]<**Insert time**> interval.

1. Voltage and Phase Configuration: Meter must be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than **0.25 inch (6 mm)** high, indicating the following:

    a. Accumulative kWh.
    b. Current time and date.
    c. Current demand.
    d. Historic peak demand.
    e. Time and date of historic peak demand.

3. Retain accumulated kWh and historic peak demand in nonvolatile memory, until reset.

G. KY and KYZ Pulse Totalizer:

1. Pulse Totalizer: Instrument for demand and billing applications where one or more utility revenue meters stream KY or KYZ energy pulses. Instrument must totalize kWh accumulated over user-selected period and must log maximum and minimum kWhd for that period. Record each period

with date/time stamp. Time period must be user selected from one to 60 minutes.

a. Pulse Input: [**One**]<**Insert number**>, individually programmable, KYZ Form C (three-wire) contact pulse channels. Pulse interval, pulse rate, and minimum pulse width must be field adjustable, set for pulse stream provided by utility revenue meter.
b. Data Totalizing Capacity of Each Channel: Not less than 149 days at 15-minute intervals.
c. Instrument Power: User selectable, 120 V(ac) and 277 V(ac).
d. Clock: Line frequency.

H. Remote Reading Options:

1. Pulse Output: [**KY**][**KYZ**], complete with optical sensor and interface devices.
2. TIA-232 serial interface.
3. TIA-485 serial interface, with [**Modbus RTU protocol**]<**Insert protocol name**>.
4. USB interface.
5. TCP/IP adapter.

I. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

J. Uninterruptible Power Supply: Single phase, 120 V(ac), sized and rated to provide continuous power to meter for operations of [**48**]<**Insert number**> hours after interruption of normal power.

1. Output: Sine wave, total harmonic distortion less than 5 percent at full load.
2. Battery: Maintenance free, sealed, lead acid, and leakproof.
3. Control Panel: LED status display of "on-battery," "replace battery," and "overload."

K. Data Transmission Cable: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

L. Software: PC-based product [**of**][**recommended by**] meter manufacturer, suitable for calculating utility cost allocation.

1. Utility Cost Allocation: Automatically import electricity-usage records to allocate electricity costs for the following:

a. At least [**15**]<**Insert number**> departments.
b. At least [**30**]<**Insert number**> tenants or activities.
c. At least [**five**]<**Insert number**> processes.
d. At least [**five**]<**Insert number**> buildings.
e. <**Insert entity**>.

2. Activity Billing Software: Automatically import electricity-usage records to automatically compute and prepare electricity-use statements[**and invoices**] based on electricity use[**and peak demand**]. Maintain separate directory for each allocation. Prepare summary reports in user-defined formats and time intervals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Install modular meter center according to switchboard installation requirements in NECA 400.
2. Install arc-flash labels as required by NFPA 70.

C. Special Techniques:

1. Install meters furnished by utility company. Install raceways and equipment according to utility company's published instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
2. Wiring Methods:

    a. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533.13 "Conduits for Electrical Systems."
    b. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
    c. Minimum conduit size is metric designator 16 (trade size 1/2).

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide additional card holder suitable for [**printed, weather-resistant card**][**typewritten card**] with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Equipment and Software Setup:

    a. Set meter date and time clock.
    b. Test, calibrate, and connect pulse metering system.
    c. Set and verify billing demand interval for demand meters.
    d. Report settings and calibration results.
    e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.

2. Connect load of known power rating, [**1.5 kW**]<**Insert kilowatts**> minimum, to circuit supplied by metered feeder.
3. Turn off circuits supplied by metered feeder and secure them in off condition.
4. Run test load continuously for eight hours minimum, or longer, to obtain measurable meter

indication. Use test-load placement and setting that ensures continuous, safe operation.

5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
6. Generate test report and billing for each tenant or activity from meter reading tests.

D. Nonconforming Work:

1. Electricity metering will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.4 PROTECTION

A. After installation, protect metering equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

    a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 26 27 13 00

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SECTION 26 27 16 00 - ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinets and cutout boxes.
2. Termination boxes.
3. Miscellaneous enclosures.
4. Rack or frame systems.
5. Enclosure-mounted power distribution.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
6. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding for RBBs referenced by this Section.
7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
8. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 DEFINITIONS

A. RBB: Rack bonding busbar, located in equipment cabinets and racks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Custom Enclosures and Cabinets: Include plans, elevations, sections, and attachment details.
2. Shop Drawings for Racks or Frames:

    a. Include plans, elevations, sections, details, and attachments to other work.
    b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    c. Include workspace requirements and access for cable connections.
    d. Grounding: Indicate location of RBB and its mounting detail showing standoff insulators and wall-mounting brackets.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 CABINETS AND CUTOUT BOXES

A. UL CYIV - Indoor Sheet Metal Cabinets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL CYIV - Indoor Sheet Metal Cutout Boxes :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Adalet; division of Scott Fetzer Co.**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Erickson Electrical Equipment Company**]
   f. [**FSR Inc.**]
   g. [**Hoffman; brand of nVent Electrical plc**]
   h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. [**Milbank Manufacturing Company**]
   j. [**N J Sullivan Company**]
   k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   l. [**Robroy Enclosures; Robroy Industries**]
   m. [**Siemens Industry, Inc., Building Technologies Division**]
   n. [**Square D; Schneider Electric USA**]
   o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Adalet; division of Scott Fetzer Co.**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   e. [**Erickson Electrical Equipment Company**]
   f. [**FSR Inc.**]
   g. [**Hoffman; brand of nVent Electrical plc**]
   h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   i. [**Milbank Manufacturing Company**]
   j. [**N J Sullivan Company**]
   k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   l. [**Robroy Enclosures; Robroy Industries**]
   m. [**Siemens Industry, Inc., Building Technologies Division**]
   n. [**Square D; Schneider Electric USA**]
   o. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. UL CCN CYIV.
   b. Non-Environmental Characteristics: UL 50.
   c. Environmental Characteristics: UL 50E.

4. Standard Features:

   a. Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
   b. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL CYIV - Outdoor Sheet Metal Cabinets :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]

o. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

D. UL CYIV - Outdoor Sheet Metal Cutout Boxes :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**ABB, Electrification Business**]
b. [**Adalet; division of Scott Fetzer Co.**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
e. [**Erickson Electrical Equipment Company**]
f. [**FSR Inc.**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Milbank Manufacturing Company**]
j. [**N J Sullivan Company**]
k. [**Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
l. [**Robroy Enclosures; Robroy Industries**]
m. [**Siemens Industry, Inc., Building Technologies Division**]
n. [**Square D; Schneider Electric USA**]
o. **<Insert manufacturer's name>**

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
b. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.5 TERMINATION BOXES

A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.

B. UL XCKT - Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    d. [**Erickson Electrical Equipment Company**]
    e. [**Hoffman; brand of nVent Electrical plc**]
    f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Milbank Manufacturing Company**]
    h. [**N J Sullivan Company**]
    i. [**Square D; Schneider Electric USA**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Appleton; Emerson Electric Co., Automation Solutions**]
    c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    d. [**Erickson Electrical Equipment Company**]
    e. [**Hoffman; brand of nVent Electrical plc**]
    f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    g. [**Milbank Manufacturing Company**]
    h. [**N J Sullivan Company**]
    i. [**Square D; Schneider Electric USA**]
    j. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. UL CCN XCKT; including UL 1773.
    b. Non-Environmental Characteristics: UL 50.
    c. Environmental Characteristics: UL 50E.

4. Standard Features:

    a. Listed and labeled for installation on line side of service equipment.
    b. Indoor Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].
    c. Outdoor Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard

development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. UL XCKT - Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Erickson Electrical Equipment Company**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Milbank Manufacturing Company**]
   h. [**N J Sullivan Company**]
   i. [**Square D; Schneider Electric USA**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Erickson Electrical Equipment Company**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Milbank Manufacturing Company**]
   h. [**N J Sullivan Company**]
   i. [**Square D; Schneider Electric USA**]
   j. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. UL CCN XCKT; including UL 1773.
   b. Non-Environmental Characteristics: UL 50.
   c. Environmental Characteristics: UL 50E.

4. Standard Features:

   a. Listed and labeled for installation on load side of service equipment.
   b. Indoor Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].
   c. Outdoor Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts

of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.6 MISCELLANEOUS ENCLOSURES

A. UL XCKT or NWIN - Indoor Sheet Metal Miscellaneous Enclosures :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Erickson Electrical Equipment Company**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Milbank Manufacturing Company**]
   h. [**N J Sullivan Company**]
   i. [**Square D; Schneider Electric USA**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Appleton; Emerson Electric Co., Automation Solutions**]
   c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
   d. [**Erickson Electrical Equipment Company**]
   e. [**Hoffman; brand of nVent Electrical plc**]
   f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   g. [**Milbank Manufacturing Company**]
   h. [**N J Sullivan Company**]
   i. [**Square D; Schneider Electric USA**]
   j. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. UL CCN XCKT; including UL 1773; or UL CCN NWIN, including UL 2416.
   b. Non-Environmental Characteristics: UL 50.
   c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Degree of Protection: [**Type 1**][**Type 2**][**Type 5**][**Type 12**][**Type 12K**][**Type 13**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

B. UL XCKT or NWIN - Outdoor Sheet Metal Miscellaneous Enclosures :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Erickson Electrical Equipment Company**]
e. [**Hoffman; brand of nVent Electrical plc**]
f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Milbank Manufacturing Company**]
h. [**N J Sullivan Company**]
i. [**Square D; Schneider Electric USA**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Appleton; Emerson Electric Co., Automation Solutions**]
c. [**Cooper B-line; brand of Eaton, Electrical Sector**]
d. [**Erickson Electrical Equipment Company**]
e. [**Hoffman; brand of nVent Electrical plc**]
f. [**Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Milbank Manufacturing Company**]
h. [**N J Sullivan Company**]
i. [**Square D; Schneider Electric USA**]
j. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN XCKT; including UL 1773; or UL CCN NWIN, including UL 2416.
b. Non-Environmental Characteristics: UL 50.

c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Degree of Protection: [**Type 3**][**Type 3X**][**Type 3R**][**Type 3RX**][**Type 3S**][**Type 3SX**][**Type 4**][**Type 4X**][**Type 6**][**Type 6P**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

2.7 RACK OR FRAME SYSTEMS

A. Description: This category covers rack or frame systems that are not complete but include components and assemblies that are intended to power, protect, heat, cool, or otherwise support electrical or electronic equipment that will be installed at a later time.

B. UL NWIN - 19 Inch Open Equipment Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**Bud Industries, Inc.**]
d. [**CommScope, Inc**]
e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
f. [**Dell Technologies Inc.**]
g. [**Hammond Mfg. Co. Inc**]
h. [**Hoffman; brand of nVent Electrical plc**]
i. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
j. [**Kendall Howard**]
k. [**Leviton Manufacturing Co., Inc.**]
l. [**Liebert; Vertiv Holdings Co.**]
m. [**Middle Atlantic Products; Legrand North America, LLC**]
n. [**Ortronics, Inc.**]
o. [**Panduit Corp**]
p. [**Siemon Co. (The)**]
q. [**Tripp-Lite**]
r. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Black Box Corporation**]
    c. [**Bud Industries, Inc.**]
    d. [**CommScope, Inc**]
    e. [**Cooper B-line; brand of Eaton, Electrical Sector**]
    f. [**Dell Technologies Inc.**]
    g. [**Hammond Mfg. Co. Inc**]
    h. [**Hoffman; brand of nVent Electrical plc**]
    i. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    j. [**Kendall Howard**]
    k. [**Leviton Manufacturing Co., Inc.**]
    l. [**Liebert; Vertiv Holdings Co.**]
    m. [**Middle Atlantic Products; Legrand North America, LLC**]
    n. [**Ortronics, Inc.**]
    o. [**Panduit Corp**]
    p. [**Siemon Co. (The)**]
    q. [**Tripp-Lite**]
    r. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. UL CCN NWIN; including UL 2416.
    b. Non-Environmental Characteristics: UL 50.
    c. Environmental Characteristics: UL 50E or UL 2416.

4. Standard Features:

    a. Threaded rails designed for mounting telecommunications equipment.
    b. Width: Compatible with EIA/ECIA 310-E, **19 inch (482.6 mm)** equipment mounting with an opening of **17.72 inch (450 mm)** between rails.
    c. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
    d. Finish: Manufacturer's standard, baked-polyester powder coat.
    e. Cable Management:

        1) Metal, with integral wire retaining fingers.
        2) Baked-polyester powder coat finish.
        3) Vertical cable management panels have front and rear channels with covers.
        4) Horizontal crossover cable manager at top of each relay rack, with minimum height of two rack units each.

    f. Configuration: [**Two post**][**and**][**four post**].
    g. Material: [**Extruded steel**][**Extruded aluminum**][**Sheet steel**][**Sheet aluminum**].

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted,

manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Color: [**Black**]<**Insert color**>.

b. Floor-Mounted Racks:

1) Overall Height: [**72 inch (1828.8 mm)**][**84 inch (2133.6 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Overall Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Rail Depth: [**3 inch (76.2 mm)**][**6 inch (152.4 mm)**]<**Insert value**>
4) Two-Post Load Rating: [**200 lb (91 kg)**][**400 lb (181 kg)**]<**Insert value**>.
5) Four-Post Load Rating: [**1000 lb (454 kg)**][**2000 lb (907 kg)**]<**Insert value**>.
6) Number of Rack Units per Rack: [**38**][**42**][**45**][**52**][**58**][**As indicated on Drawings**]<**Insert number**>.

a) Numbering: [**Every**][**Every five**] rack unit(s), on interior of rack.

7) Threads: [**10-32**][**12-24**][**Universal square**].
8) Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug[**, and a power strip**].
9) Base must have minimum four mounting holes for permanent attachment to floor.
10) Top must have provisions for attaching to cable tray or ceiling.
11) Self-leveling.

c. Wall-Mounted Racks:

1) Height: [**18 inch (457.2 mm)**][**22 inch (558.8 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**150 lb (65 kg)**][**200 lb (91 kg)**]<**Insert value**>.
4) Number of Rack Units per Rack: [**8**][**12**][**22**][**As indicated on Drawings**]<**Insert number**>.
5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Wall Attachment: Four pre-punched mounting holes.
7) Equipment Access: Integral swing.

C. UL NWIN - 19 Inch Enclosed Equipment Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**Bud Industries, Inc.**]
d. [**Chatsworth Products, Inc.**]

e. [**CommScope, Inc**]
f. [**Cooper B-line; brand of Eaton, Electrical Sector**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kendall Howard**]
j. [**Leviton Manufacturing Co., Inc.**]
k. [**Liebert; Vertiv Holdings Co.**]
l. [**Middle Atlantic Products; Legrand North America, LLC**]
m. [**Ortronics, Inc.**]
n. [**Panduit Corp**]
o. [**Siemon Co. (The)**]
p. [**Tripp-Lite**]
q. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**Bud Industries, Inc.**]
d. [**Chatsworth Products, Inc.**]
e. [**CommScope, Inc**]
f. [**Cooper B-line; brand of Eaton, Electrical Sector**]
g. [**Hoffman; brand of nVent Electrical plc**]
h. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
i. [**Kendall Howard**]
j. [**Leviton Manufacturing Co., Inc.**]
k. [**Liebert; Vertiv Holdings Co.**]
l. [**Middle Atlantic Products; Legrand North America, LLC**]
m. [**Ortronics, Inc.**]
n. [**Panduit Corp**]
o. [**Siemon Co. (The)**]
p. [**Tripp-Lite**]
q. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN NWIN; including UL 2416.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E or UL 2416.

4. Standard Features:

a. Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment.
b. Threaded rails designed for mounting telecommunications equipment.
c. Width: Compatible with EIA/ECIA 310-E, **19 inch (482.6 mm)** equipment mounting with an opening of **17.72 inch (450 mm)** between rails.
d. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
e. Finish: Manufacturer's standard, baked-polyester powder coat.
f. Cable Management:

1) Metal, with integral wire retaining fingers.
2) Baked-polyester powder coat finish.
3) Vertical cable management panels have front and rear channels with covers.
4) Horizontal crossover cable manager at top of each relay rack, with minimum height of two rack units each.

g. Material: [**Extruded steel**][**Extruded aluminum**][**Sheet steel**][**Sheet aluminum**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Color: [**Black**]<**Insert color**>.
b. Modular Freestanding Cabinets:

1) Overall Height: [**72 inch (1828.8 mm)**][**84 inch (2133.6 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Overall Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**3000 lb (1362 kg)**]<**Insert value**>.
4) Number of Rack Units: [**38**][**42**][**45**][**52**][**58**][**As indicated on Drawings**]<**Insert number**>.

a) Numbering: [**Every**][**Every five**] rack unit(s), on interior of rack.

5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Removable and lockable side and top panels.
7) Hinged and lockable front and rear doors.
8) Adjustable feet for leveling.
9) Screened ventilation openings in roof and rear door.
10) Cable access provisions in roof and base.
11) RBB.
12) [**Rack**][**Roof**]-mounted, **550 cfm (260 L/s)** fan with filter.
13) Power strip.
14) All cabinets keyed alike.

c. Modular Wall Cabinets:

1) Height: [**18 inch (457.2 mm)**][**22 inch (558.8 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**150 lb (65 kg)**][**200 lb (91 kg)**]<**Insert value**>.
4) Number of Rack Units: [**8**][**12**][**22**][**As indicated on Drawings**]<**Insert number**>.

5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Lockable front[**and rear**] doors.
7) Louvered side panels.
8) Cable access provisions top and bottom.
9) Grounding lug.
10) [**Rack**][**Roof**]-mounted, **250 cfm (118 L/s)** fan.
11) Power strip.
12) All cabinets keyed alike.

D. UL NWIN - 23 Inch Open Equipment Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**CommScope, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Hoffman; brand of nVent Electrical plc**]
f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Kendall Howard**]
h. [**Leviton Manufacturing Co., Inc.**]
i. [**Liebert; Vertiv Holdings Co.**]
j. [**Middle Atlantic Products; Legrand North America, LLC**]
k. [**Ortronics, Inc.**]
l. [**Panduit Corp**]
m. [**Siemon Co. (The)**]
n. [**Tripp-Lite**]
o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**CommScope, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Hoffman; brand of nVent Electrical plc**]
f. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Kendall Howard**]
h. [**Leviton Manufacturing Co., Inc.**]
i. [**Liebert; Vertiv Holdings Co.**]
j. [**Middle Atlantic Products; Legrand North America, LLC**]
k. [**Ortronics, Inc.**]
l. [**Panduit Corp**]
m. [**Siemon Co. (The)**]
n. [**Tripp-Lite**]
o. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN NWIN; including UL 2416.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E or UL 2416.

4. Standard Features:

a. Threaded rails designed for mounting telecommunications equipment.
b. Width: Compatible with **23 inch (584.2 mm)** equipment mounting.
c. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
d. Finish: Manufacturer's standard, baked-polyester powder coat.
e. Cable Management:

1) Metal, with integral wire retaining fingers.
2) Baked-polyester powder coat finish.
3) Vertical cable management panels have front and rear channels with covers.
4) Horizontal crossover cable manager at top of each relay rack, with minimum height of two rack units each.

f. Configuration: [**Two post**][**and**][**four post**].
g. Material: [**Extruded steel**][**Extruded aluminum**][**Sheet steel**][**Sheet aluminum**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Color: [**Black**]<**Insert color**>.
b. Floor-Mounted Racks:

1) Overall Height: [**72 inch (1828.8 mm)**][**84 inch (2133.6 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Overall Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Rail Depth: [**3 inch (76.2 mm)**][**6 inch (152.4 mm)**]<**Insert value**>
4) Two-Post Load Rating: [**200 lb (91 kg)**][**400 lb (181 kg)**]<**Insert value**>.
5) Four-Post Load Rating: [**1000 lb (454 kg)**][**2000 lb (907 kg)**]<**Insert value**>.
6) Number of Rack Units per Rack: [**38**][**42**][**45**][**52**][**58**][**As indicated on Drawings**]<**Insert number**>.

a) Numbering: [**Every**][**Every five**] rack unit(s), on interior of rack.

7) Threads: [**10-32**][**12-24**][**Universal square**].
8) Vertical and horizontal cable management channels, top and bottom cable troughs,

grounding lug[, **and a power strip**].
9) Base must have minimum four mounting holes for permanent attachment to floor.
10) Top must have provisions for attaching to cable tray or ceiling.
11) Self-leveling.

c. Wall-Mounted Racks:

1) Height: [**18 inch (457.2 mm)**][**22 inch (558.8 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**150 lb (65 kg)**][**200 lb (91 kg)**]<**Insert value**>.
4) Number of Rack Units per Rack: [**8**][**12**][**22**][**As indicated on Drawings**]<**Insert number**>.
5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Wall Attachment: Four pre-punched mounting holes.
7) Equipment Access: Integral swing.

E. UL NWIN - 23 Inch Enclosed Equipment Rack :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**CommScope, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Dell Technologies Inc.**]
f. [**Hoffman; brand of nVent Electrical plc**]
g. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Kendall Howard**]
i. [**Leviton Manufacturing Co., Inc.**]
j. [**Liebert; Vertiv Holdings Co.**]
k. [**Middle Atlantic Products; Legrand North America, LLC**]
l. [**Ortronics, Inc.**]
m. [**Panduit Corp**]
n. [**Siemon Co. (The)**]
o. [**Tripp-Lite**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Black Box Corporation**]
c. [**CommScope, Inc**]
d. [**Cooper B-line; brand of Eaton, Electrical Sector**]
e. [**Dell Technologies Inc.**]
f. [**Hoffman; brand of nVent Electrical plc**]
g. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
h. [**Kendall Howard**]

i. [**Leviton Manufacturing Co., Inc.**]
j. [**Liebert; Vertiv Holdings Co.**]
k. [**Middle Atlantic Products; Legrand North America, LLC**]
l. [**Ortronics, Inc.**]
m. [**Panduit Corp**]
n. [**Siemon Co. (The)**]
o. [**Tripp-Lite**]
p. <**Insert manufacturer's name**>

3. Listing Criteria:

a. UL CCN NWIN; including UL 2416.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E or UL 2416.

4. Standard Features:

a. Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment.
b. Threaded rails designed for mounting telecommunications equipment.
c. Width: Compatible with **23 inch (584.2 mm)** equipment mounting.
d. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
e. Finish: Manufacturer's standard, baked-polyester powder coat.
f. Cable Management:

1) Metal, with integral wire retaining fingers.
2) Baked-polyester powder coat finish.
3) Vertical cable management panels have front and rear channels with covers.
4) Horizontal crossover cable manager at top of each relay rack, with minimum height of two rack units each.

g. Material: [**Extruded steel**][**Extruded aluminum**][**Sheet steel**][**Sheet aluminum**].

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

a. Color: [**Black**]<**Insert color**>.
b. Modular Freestanding Cabinets:

1) Overall Height: [**72 inch (1828.8 mm)**][**84 inch (2133.6 mm)**][**As indicated on**

Drawings]<**Insert value**>.
2) Overall Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**3000 lb (1362 kg)**]<**Insert value**>.
4) Number of Rack Units: [**38**][**42**][**45**][**52**][**58**][**As indicated on Drawings**]<**Insert number**>.

a) Numbering: [**Every**][**Every five**] rack unit(s), on interior of rack.

5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Removable and lockable side and top panels.
7) Hinged and lockable front and rear doors.
8) Adjustable feet for leveling.
9) Screened ventilation openings in roof and rear door.
10) Cable access provisions in roof and base.
11) RBB.
12) [**Rack**][**Roof**]-mounted, **550 cfm (260 L/s)** fan with filter.
13) Power strip.
14) All cabinets keyed alike.

c. Modular Wall Cabinets:

1) Height: [**18 inch (457.2 mm)**][**22 inch (558.8 mm)**][**As indicated on Drawings**]<**Insert value**>.
2) Depth: [**23 inch (584.2 mm)**][**29 inch (736.6 mm)**]<**Insert value**>.
3) Load Rating: [**150 lb (65 kg)**][**200 lb (91 kg)**]<**Insert value**>.
4) Number of Rack Units: [**8**][**12**][**22**][**As indicated on Drawings**]<**Insert number**>.
5) Threads: [**10-32**][**12-24**][**Universal square**].
6) Lockable front[**and rear**] doors.
7) Louvered side panels.
8) Cable access provisions top and bottom.
9) Grounding lug.
10) [**Rack**][**Roof**]-mounted, **250 cfm (118 L/s)** fan.
11) Power strip.
12) All cabinets keyed alike.

2.8 ENCLOSURE-MOUNTED POWER DISTRIBUTION

A. Description: This category covers relocatable power taps and power distribution units.

B. UL XBYS - Enclosure-Mounted Relocatable Power Tap :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. <**Insert manufacturer's name**>

3. Listing Criteria: UL CCN XBYS; including UL 1363.
4. Standard Features:

    a. Rocker-type on-off switch, illuminated when in on position.
    b. LED indicator lights for power and protection status.
    c. LED indicator lights for reverse polarity and open outlet ground.

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Wiring Devices: [**Six**]<**Insert quantity**>[**5-15R**][**5-20R**]<**Insert type**> receptacles.
    b. Circuit Breaker and Thermal Fusing: [**When protection is lost, circuit opens and cannot be reset**][**Unit continues to supply power if protection is lost**].
    c. Cord Length: [**Close-coupled, direct plug-in**][**15 ft (4.5 m)**].
    d. Surge Protection: Type 3 SPDs.

        1) Peak Single-Impulse Surge Current Rating: [**33**][**26**][**13**] kA per phase.
        2) Protection modes must be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes may not be more than [**330 V**]<**Insert value**>.

C. UL QPQY - Rack-Mounted Power Distribution Center :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB, Electrification Business**]
    b. [**Fujitsu Network Communications**]
    c. [**Vertiv Co.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB, Electrification Business**]
    b. [**Fujitsu Network Communications**]
    c. [**Vertiv Co.**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria: UL CCN QPQY; including UL 62368-1 or UL 60950-1, in addition to UL Subject 1801.
4. Standard Features:

    a. Input Voltage: [**120 V**][**208 V**][**120/208 V**][**208Y/120 V**][**208 V Delta**].
    b. Input Current: [**15 A**][**20 A**][**30 A**].
    c. Output Receptacle Types and Quantities:

        1) 5-15R: [**6**][**8**][**10**][**12**][**14**][**20**].
        2) 5-20R: [**6**][**10**][**12**][**20**].
        3) L5-20R: [**6**][**12**][**24**].
        4) L5-30R: 6.
        5) L6-20R: [**1**][**12**][**20**][**24**].
        6) L6-30R: [**1**][**6**].
        7) L21-30R: 1.

5. Sustainable Design Features:

    a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
    b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
    c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
    d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
    e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Other Available Features Required by the Project:

    a. Rack transfer switch.
    b. Switched receptacles.
    c. Monitoring: [**Unit level**][**Outlet level**].
    d. Sensors:

        1) Temperature: [**1**][**3**].
        2) Humidity.
        3) Dew point.
        4) Airflow.
        5) Plug-and-play dry contact.
        6) Door position.
        7) Water.
        8) Power failure.

PART 3 - EXECUTION

3.1 SELECTION OF ELECTRICAL CABINETS AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written

instructions, comply with NFPA 70 for selection of electrical cabinets and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. [**Type 3R**][**Type 4**][**Type 3**] unless otherwise indicated.
b. Locations Exposed to Hosedown: [**Type 4**][**Type 6**][**Type 6P**].
c. Locations Subject to Potential Flooding: Type 6P.
d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
e. Locations in-Ground or Exposed to Corrosive Agents: [**Type 4X**][**Type 6P**][**Type 3RX**].
f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.
b. Damp or Dusty Locations: [**Type 12**][**Type 2**][**Type 4**][**Type 5**].
c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: [**Type 12**][**Type 12K**].
e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: [**Type 4**][**Type 6**].
f. Locations Exposed to Hosedown: [**Type 4**][**Type 6**][**Type 6P**].
g. Locations Exposed to Brief Submersion: [**Type 6**][**Type 6P**].
h. Locations Exposed to Prolonged Submersion: Type 6P.
i. Locations Exposed to Corrosive Agents: [**Type 4X**][**Type 6P**].
j. Locations Exposed to Spraying Oil or Coolants: Type 13.

3.2 INSTALLATION OF ELECTRICAL CABINETS AND ENCLOSURES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in ITE Rooms: NFPA 75.
6. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
7. Cabinets and Cutout Boxes: Article 312 of NFPA 70.
8. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Mount cabinets and enclosures at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to [**center**][**top**][**bottom**] of box unless otherwise indicated.
2. Do not install cabinets, enclosures, or fittings in contact with concrete or earth.
3. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
4. Identification: Provide labels for cabinets, enclosures, racks and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Provide warning signs.
c. Label each cabinet, enclosure, and rack with engraved metal or laminated-plastic nameplate.

D. Interfaces with Other Work:

1. Firestop penetrations of rated walls and partitions.
2. Ground and bond RBBs in cabinets, enclosures, and racks.
3. Apply arc-flash hazard warning labels cabinets, enclosures, and racks.
4. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

5. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.3 FIELD QUALITY CONTROL OF ELECTRICAL CABINETS AND ENCLOSURES

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Cabinet, enclosure, or rack will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Remove construction dust and debris from cabinets, enclosures, and racks.

3.5 PROTECTION

A. Protect coatings and finishes of cabinets, enclosures, and racks from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 27 16 00

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Task	Specification	Specification Description
26 27 16 00	26 09 23 00	Electrical Power Monitoring
26 27 16 00	26 24 19 00	Motor-Control Centers

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SECTION 26 27 19 00 - MULTI-OUTLET ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall-mounted, surface metal raceway multi-outlet assemblies.
2. Wall-mounted, surface nonmetallic raceway multi-outlet assemblies.
3. Floor-mounted, recessed metal raceway multi-outlet assemblies.
4. Indoor service poles.
5. Floor-mounted, enclosure multi-outlet assemblies.
6. Fire-rated, poke-through assemblies.
7. Above-floor service fittings.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260533.13 "Conduits for Electrical Systems" and Section 260533.23 "Surface Raceways for Electrical Systems" for raceways.
4. Section 260533.16 "Boxes and Covers for Electrical Systems" for floor boxes and covers.
5. Section 262726 "Wiring Devices" for receptacles and switches.
6. Section 271513 "Communications Copper Horizontal Cabling" for control-voltage communications outlet devices.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Wall-mounted, surface metal raceway multi-outlet assemblies.
2. Wall-mounted, surface nonmetallic raceway multi-outlet assemblies.
3. Floor-mounted, recessed metal raceway multi-outlet assemblies.
4. Indoor service poles.
5. Floor-mounted, enclosure multi-outlet assemblies.
6. Fire-rated, poke-through assemblies.
7. Above-floor service fittings.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED, SURFACE METAL RACEWAY MULTI-OUTLET ASSEMBLIES

A. Description: Two-piece surface metal raceway, field assembled and wired or with factory-wired multi-outlet harness, including outlets.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 5 for exposed power raceway and fittings. Multi-outlet assemblies used for communications or data must also comply with UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
2. Provide separate paths for management of telecommunications and power cables.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways, receptacles, and switches.

E. Wall-Mounted, Surface Metal Raceway Power Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Wiremold; Legrand North America, LLC**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Wiremold; Legrand North America, LLC**]
    c. <**Insert manufacturer's name**>

3. Options:

    a. Material: [**Steel**][**Aluminum**], with manufacturer's standard finish.
    b. Color: <**Indicate color**>.
    c. Power Outlets: <**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
    d. Power Outlet Spacing: [**6 inch (150 mm)**][**9 inch (230 mm)**][**12 inch (300 mm)**][**18 inch (460 mm)**].
    e. Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles or switches,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Wall-Mounted, Surface Metal Raceway Power and Communications Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell**

Incorporated]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

3. Options:

a. Material: [**Steel**][**Aluminum**], with manufacturer's standard finish.
b. Color: <**Indicate color**>.
c. Power Outlets: <**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
d. Power Outlet Spacing: [**6 inch (150 mm)**][**9 inch (230 mm)**][**12 inch (300 mm)**][**18 inch (460 mm)**].
e. Power Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles or switches,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
f. Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
g. A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.2 WALL-MOUNTED, SURFACE NONMETALLIC RACEWAY MULTI-OUTLET ASSEMBLIES

A. Description: Two-piece surface nonmetallic raceway, field assembled and wired or with factory-wired multi-outlet harness, including outlets.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 5A for exposed power raceway and fittings, UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
2. Provide separate paths for management of telecommunications and power cables.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways, receptacles, and switches.

E. Wall-Mounted, Surface Nonmetallic Raceway Power Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

3. Options:

a. Material: [**PVC**]<**Indicate material**>.
b. Color: <**Indicate color**>.
c. Power Outlets: <**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
d. Power Outlet Spacing: [**6 inch (150 mm)**][**9 inch (230 mm)**][**12 inch (300 mm)**][**18 inch (460 mm)**].
e. Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles or switches,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Wall-Mounted, Surface Nonmetallic Raceway Power and Communications Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

3. Options:

a. Material: [**PVC**]<**Indicate material**>.
b. Color: <**Indicate color**>.
c. Power Outlets: <**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
d. Power Outlet Spacing: [**6 inch (150 mm)**][**9 inch (230 mm)**][**12 inch (300 mm)**][**18 inch (460 mm)**].

e. Power Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles or switches,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
f. Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
g. A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.3 FLOOR-MOUNTED, RECESSED METAL RACEWAY MULTI-OUTLET ASSEMBLIES

A. Description: Two-piece flush-mounted, in-floor, metal raceway, with factory-wired multi-outlet harness, for installation flush in floor or under floor finish.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 5 for exposed power raceway and fittings, UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
2. Provide separate paths for management of telecommunications and power cables.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

E. Floor-Mounted, Recessed Metal Raceway Power Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Wiremold; Legrand North America, LLC**]
c. <**Insert manufacturer's name**>

3. Options:

a. Load-Bearing Capacity: [**1000 lb (450 kg)**]<**Indicate capacity**>.
b. Material: [**Steel**][**Aluminum**], with manufacturer's standard finish.
c. Color: <**Indicate color**>.
d. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices" in surface-mounted enclosure capable of mounting

anywhere along length of recessed raceway.

e. Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Floor-Mounted, Recessed Metal Raceway Power and Communications Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Wiremold; Legrand North America, LLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Wiremold; Legrand North America, LLC**]
   c. <**Insert manufacturer's name**>

3. Options:

   a. Load-Bearing Capacity: [**1000 lb (450 kg)**]<**Indicate capacity**>.
   b. Material: [**Steel**][**Aluminum**], with manufacturer's standard finish.
   c. Color: <**Indicate color**>.
   d. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices" in surface-mounted enclosure capable of mounting anywhere along length of recessed raceway.
   e. Power Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   f. Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
   g. A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.4 INDOOR SERVICE POLES

A. Description: Factory-assembled and -wired, exposed raceway and fittings to route electrical wiring from connections above ceiling to outlets below ceiling.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 5 for exposed power raceway and fittings, and UL 2024 for communications raceway and fittings.

2. Listed and labeled in accordance with NFPA 90A for installation in air-handling plenum spaces.
3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to above ceiling structural supports; with pole foot and carpet pad attachment.
4. Provide barrier to separate channel for power wiring from channel for voice and data communication cabling.

D. Indoor Service Pole :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Panduit Corp**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Panduit Corp**]
    c. <**Insert manufacturer's name**>

3. Options:

    a. Material: [**Aluminum**][**Steel**].
    b. Height: <**Insert height**> below ceiling, and <**Insert height**> above ceiling.
    c. Finish: [**Manufacturer's standard painted finish and trim combination**][**Satin-anodized aluminum**].

        1) Color: [**Clear anodized**][**White**][**Ivory**][**Gray**][**Black**]<**Insert color**>.

    d. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
    e. Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
    f. Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
    g. A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.5 FLOOR-MOUNTED ENCLOSURE MULTI-OUTLET ASSEMBLIES

A. Description: Floor-mounted box with cover enclosing multiple power[**and communications**] outlets in a single assembly.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 514A for metallic boxes; UL 514C for nonmetallic boxes, including scrub-water exclusion requirements; and UL 514D for cover plates.
2. Provide separate paths for management of telecommunications and power cables in accordance with NFPA 76.
3. Compartments: Barrier separates power from voice and data communication cabling.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

E. Floor-Mounted Enclosure Multi-Outlet Assembly :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB, Electrification Business**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Wiremold; Legrand North America, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB, Electrification Business**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Wiremold; Legrand North America, LLC**]
   d. <**Insert manufacturer's name**>

3. Options:

   a. Floor Box and Cover:

      1) [**Provide floor boxes classified for use in 1-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.**]
      2) [**Provide floor boxes classified for use in 1-1/2-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.**]
      3) [**Provide floor boxes classified for use in 2-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.**]
      4) [**Provide floor boxes classified for use in 3-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.**]
      5) [**Provide floor boxes for installation in raised floors.**]
      6) [**Provide floor boxes for installation in wood floors.**]
      7) Floor boxes for concrete floors must provide a minimum of **4 inch (100 mm)** of adjustment prior to concrete pour and a minimum of **1/2 inch (12.5 mm)** after concrete is set.
      8) Provide [**cast-metal**][**sheet metal**][**nonmetallic**] floor boxes with [**four**][**six**][**eight**][**10**] gangs.
      9) Provide brass or aluminum flanges approved for use on carpet, tile, or wood floor applications. Flanges and cover plates must have a buffed appearance and a

protective finish. Covers must match appearance of floor flanges and provide access to included devices.

10) Covers must lay flat on floor surface when open. Provide for cable egress when cover is closed. Provide ADA-compliant covers.
11) Provide flanges, mounting brackets, keystones, and accessories for mounting devices and connections indicated on Drawings.

b. Outlets:

1) Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> in accordance with Section 262726 "Wiring Devices."
2) Wiring: [**Single circuit**][**Two circuits, connecting alternating receptacles,**] in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
3) Voice and Data Communication Outlets: <**Indicate quantity**>[**blank insert with bushed cable opening**][**8PSJ jacks**] complying with requirements in Section 271500 "Communications Horizontal Cabling."
4) A minimum of [**two**][**four**] four-pair cables in accordance with Section 271513 "Communications Copper Horizontal Cabling" for each outlet.

2.6 FIRE-RATED, POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated assembly of below-floor junction box with multichannel, through-floor raceway/firestop unit with receptacles or communications outlets installed below floor surface level.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. General Characteristics:

1. Reference Standards: UL 514A for metallic boxes and UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.
2. Provide separate paths for management of telecommunications and power cables.
3. Fire Rating: Provide unit listed and labeled for fire rating of floor-ceiling assembly.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

E. Fire-Rated, Poke-Through Assembly : [**Recessed**][**Flush**][**Pedestal**] type.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Square D; Schneider Electric USA**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Square D; Schneider Electric USA**]
c. [**Wiremold; Legrand North America, LLC**]
d. <**Insert manufacturer's name**>

3. Options:

a. Modular, [**recessed**][**flush**][**pedestal**]-type, dual-service units suitable for wiring method used[**, with cover flush with finished floor**].
b. Service Plate, Flaps, and Cover: [**Rectangular**][**Round**], [**die-cast aluminum**][**solid brass**] with satin finish.
c. Core Size: Selected to fit nominal [**4 inch (100 mm)**][**6 inch (150 mm)**][**8 inch (200 mm)**][**10 inch (250 mm)**] cored holes in floor and matched to floor thickness.
d. Closure Plug: Close unused cored opening and reestablish fire rating of floor.
e. Feed Conduits: Provide connection points for conduits as indicated on Drawings or required for conductors shown. Provide minimum [**1 inch (25 mm)**]<**Insert nominal size**> conduits for communications cables.
f. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> gray finish, unless otherwise indicated, in accordance with Section 262726 "Wiring Devices."
g. Telephone and Data Outlets: <**Indicate quantity**>[**blank cover with bushed cable opening.**][**modular, keyed, color-coded, 8PSJ jacks in accordance with Section 271513 "Communications Copper Horizontal Cabling."**]
h. Audio and Video Outlets: [**Blank cover with bushed cable opening**]<**Indicate quantity and type**>.

2.7 ABOVE-FLOOR SERVICE FITTINGS

A. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

B. General Characteristics:

1. Reference Standards: UL 514A for metallic boxes and UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.
2. Provide separate paths for management of telecommunications and power cables in compliance with NFPA 76.
3. See Section 260533.16 "Boxes and Covers for Electrical Systems" for more details and requirements for floor boxes.
4. Compartments: Barrier separates power from voice and data communication cabling.

C. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

D. Pedestal-Type, Above-Floor Service Fitting :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]

c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Wiremold; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Wiremold; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Options:

a. Service Plate and Housing: [**die-cast aluminum**][**solid brass**] with satin finish.
b. Wiring, Raceways, and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of [**two**][**four**] four-pair cables in accordance with Section 260533.23 "Surface Raceways for Electrical Systems" and Section 271513 "Communications Copper Horizontal Cabling."
c. Power Outlets: <**Indicate quantity**><**Indicate receptacle type**> gray finish, unless otherwise indicated, in accordance with Section 262726 "Wiring Devices."
d. Communications Outlets: <**Indicate quantity**>[**blank cover with bushed cable opening.**][**modular, keyed, color-coded, 8PSJ jacks in accordance with Section 271513 "Communications Copper Horizontal Cabling."**]

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1 for device mounting heights, except where requirements on Drawings or in this Section are stricter.

B. Comply with NECA 101 for installation requirements for steel raceways, except where requirements on Drawings or in this Section are stricter.

C. Comply with NECA 102 for installation requirements for aluminum raceways, except where requirements on Drawings or in this Section are stricter.

D. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies.

E. Provide terminations, adapters, boxes, and other fittings required for installation.

F. Install surface raceway with a minimum **2 inch (50 mm)** radius control at bend points.

G. Secure metallic surface raceway with screws or other anchor-type devices at intervals not exceeding **48 inch (1200 mm)** and with no fewer than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's instructions. Tape and glue are unacceptable support methods.

H. Do not install aluminum raceways or fittings in contact with concrete.

I. Secure nonmetallic surface raceway with screws or other anchor-type devices in each wiring channel at intervals not exceeding **18 inch (460 mm)** and with no fewer than two supports per straight raceway section in each wiring channel. Support nonmetallic surface raceway in accordance with manufacturer's instructions. Tape and glue are unacceptable support methods.

J. Do not install PVC raceways where ambient temperature exceeds [**122 deg F (50 deg C)**]<**Insert temperature**>. Conductors with insulation rated higher than 75 deg C installed in PVC raceways may not be operated at a temperature greater than 75 deg C.

K. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

L. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and support.

M. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.23 "Surface Raceways for Electrical Systems" for installation of raceways.

N. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for additional requirements for floor boxes.

O. Coordination with Other Work:

1. Adjust locations of multi-outlet assemblies to suit arrangement of partitions and furnishings. Locate outlets to avoid blocking by supports, furnishings, and other architectural fixtures.
2. Provide outlets with special requirements, such as GFCI, AFCI, or special environmental requirements, where required by Drawings or to meet codes.
3. Adjust locations of poke-through assembly penetrations to coordinate with locations of structural members, concealed piping, and concealed conduit. Obtain written approval from Architect prior to drilling penetrations in floors other than where dimensioned on architectural Drawings. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

END OF SECTION 26 27 19 00

Task	Specification	Specification Description
26 27 19 00	26 05 39 00	Underfloor Raceways For Electrical Systems
26 27 23 00	26 27 26 00	Wiring Devices

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SECTION 26 27 26 00 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Cord reels and fittings.
9. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies covers and cover plates referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
8. Section 260936 "Modular Dimming Controls" for multiscene and multipreset dimming controls.
9. Section 260943.16 "Addressable Luminaire Lighting Controls" for network lighting control solid-state devices.
10. Section 260943.23 "Relay-Based Lighting Controls" for network lighting control relay devices.
11. Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches" for additional wiring device products.
12. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for additional wiring device products.
13. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for additional wiring device products.
14. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for additional wiring device products.
15. Section 262726.37 "Receptacles with Arc-Fault and Ground-Fault Protective Devices" for additional wiring device products.
16. Section 262726.39 "Locking Receptacles" for additional wiring device products.
17. Section 262726.41 "Pin-and-Sleeve Receptacles" for additional wiring device products.

18. Section 262726.43 "Special-Purpose Power Outlet Assemblies" for additional wiring device products.
19. Section 262726.51 "Connectors, Cords, and Plugs" for additional wiring device products.
20. Section 270528 "Pathways for Communications Systems" [**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 DEFINITIONS

A. AFCI: Arc-Fault Circuit Interrupter.

B. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

C. GFCI: Ground-Fault Circuit Interrupter.

D. SPD: Surge Protective Device.

E. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference [**at the Project site**][**by web conference**].

B. Preinstallation Coordination Meeting(s): For ceiling-mounted cable reels. Conduct meeting [**as videoconference**][**at Project site**].

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect [**Construction Manager**][**and the Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

2. Include manufacturer's sample extended warranty language.

B. Samples: One for each type of product specified, in each finish and color specified for [**public spaces**] .

C. Shop Drawings: Prepare and submit wiring diagrams for duplex straight-blade receptacles with integral switching means.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

2. Lighting Control Documentation: Floor plans indicating the following information:

a. As-installed locations of switches and dimmers.
b. Lighting zones and control strategy for each switch or dimmer, including unoccupied time-delay setting for shut-off and override time-delay setting for shut-off.
c. Multilevel or dimming range capability for each switch or dimmer.
d. Which switches or dimmers are operated by occupancy sensors, vacancy sensors, daylighting sensors, or time clocks.

3. Record floor plan Drawings indicating as-installed locations of switches and dimmers, indicating lighting zone's each device control, to verify extent of ability of the installed Work to provide occupant control for customizing environment.
4. Record floor plan Drawings indicating as-installed locations of uncontrolled and marked controlled receptacles superimposed on office furniture layout, to verify extent of ability of the installed Work to provide each occupant ability to select at least one uncontrolled receptacle and at least one controlled receptacle for powering workspace equipment. Indicate locations of UL-approved relocatable power taps and power strips, indicating means of securing protection from damage and accessibility for inspection. Indicate locations of temporary extension cords, indicating plan for replacing them with permanent wiring within 90 days.

5. Product Data for Automated Demand Response Controls: For automated demand response controls connected to [**HVAC systems,**][**lighting systems,**][**automatic receptacle controls,**][**service water heating,**][**and**][**electric vehicle supply equipment**] .

E. Field QC Reports: For specified tests and inspections.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: For wiring devices.

B. Field Reports: Manufacturer's field reports for field QC support.

1.6 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Special manufacturer extended warranty for devices and cord reels and fittings.
2. Special installer extended warranty for devices and cord reels and fittings.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish straight-blade receptacles and connectors, cords, and plugs.

B. Special Tools: Furnish straight-blade receptacles and connectors, cords, and plugs.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able

to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.9 WARRANTY FOR DEVICES

A. Special Installer Extended Warranty: Installer warrants that installed devices perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to the Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Three**][**Four**][**Five**] years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

2. Follow-On Extended Warranty Period: [**Eight**] years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**] , freight prepaid.

1.10 WARRANTY FOR CORD REELS AND FITTINGS

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to repair or replace assemblies that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: [**Two**][**Three**][**Four**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Three**][**Four**][**Five**] years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

2. Follow-On Extended Warranty Period: [**Eight**] years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**] , freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Description:

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Description:

1. Sustainable Design Features:

a. Material Reuse: Product is salvaged, refurbished, or reused.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance**

with NEMA WD 1][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .

b. Configuration:

1) General-duty, 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
2) General-duty, 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
3) Extra-heavy-duty, 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
4) Extra-heavy-duty, 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
5) Extra-heavy-duty, 120-277 V, 30 A, [**single pole**][**double pole**][**three way**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Toggle Switch with Forked Key Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Black**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) 120-277 V, 15 A, [**single pole**][**double pole**][**three way**][**four way**] .
2) 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .
3) 120-277 V, 30 A, [**single pole**][**double pole**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

C. Rocker Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) 120-277 V, 15 A, [**single pole**][**three way**][**four way**] .
      2) 120-277 V, 20 A, [**single pole**][**double pole**][**three way**][**four way**] .

5. Sustainable Design Features:

   a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

   b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

   c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

   d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

   e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Rocker Switch with Nightlight :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Flush Switches: UL CCN WMUZ and UL 20.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration: 120-277 V, 20 A, [**single pole**][**three way**][**four way**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Type I Dimmer Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**GE Lighting; a Savant Company**]
c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Lutron Electronics Co., Inc**]
f. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. General-Use Switch Dimmers: UL CCN EOYX and UL 1472.

4. Standard Features:

a. UL 1472 Type I dimmer.

b. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
c. Switch Style: [**Toggle**][**Rocker**][**Push button**] .
d. Dimming Control Style: [**Slide**][**Rotary**] .

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Air-Gap Fan-Speed Controller Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. Fan-Speed Controls: UL CCN GQHG and UL 1917.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

5. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**] corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

c. Regional Materials (IgCC): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.5 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

A. Single Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**][**NEMA 5-30R**][**NEMA 5-50R**] .
2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
3) General-duty, [**NEMA 6-15R**][**NEMA 6-20R**][**NEMA 6-30R**][**NEMA 6-50R**] .
4) General-duty, smooth face, NEMA 6-20R.
5) General-duty, [**NEMA 14-30R (Dryer)**][**NEMA 14-50R (Range)**] .
6) Heavy-duty, [**NEMA 5-30R**][**NEMA 5-50R**] .
7) Heavy-duty, [**NEMA 6-30R**][**NEMA 6-50R**] .
8) Heavy-duty, [**NEMA 7-20R**][**NEMA 7-30R**][**NEMA 7-50R**] .
9) Heavy-duty, [**NEMA 14-20R**][**NEMA 14-30R (Dryer)**][**NEMA 14-50R (Range)**][**NEMA 14-60R**] .
10) Heavy-duty, [**NEMA 15-20R**][**NEMA 15-30R**][**NEMA 15-50R**][**NEMA 15-60R**] .
11) Heavy-duty, [**NEMA 18-20R**][**NEMA 18-30R**][**NEMA 18-50R**][**NEMA 18-60R**] .
12) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
13) Extra-heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant, Clock Hanger Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

   a. Finish: [**White nylon**][**Ivory nylon**][**Brass**][**Stainless steel**][**Brushed brass**][**Nickel plated**] .
   b. Configuration: Recessed, smooth wallplate; [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

C. Tamper-Resistant, Floor-Mounted Display Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

3. Standard Features:

   a. Finish: [**Brushed brass**][**Nickel plated**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

2.6 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Leviton Manufacturing Co., Inc.**]
   c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
3) General-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
4) General-duty, smooth face, [**NEMA 6-15R**][**NEMA 6-20R**] .
5) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
6) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
7) Heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
8) Heavy-duty, smooth face, NEMA 6-15R.
9) Heavy-duty, NEMA 7-15R.
10) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
11) Extra-heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
12) Extra-heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .
13) Extra-heavy-duty, smooth face, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      4) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      5) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Isolated Ground Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Leviton Manufacturing Co., Inc.**]
   b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
   b. Configuration:

      1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      2) General-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      4) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
      5) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
      6) Extra heavy-duty, [**NEMA 6-15R**][**NEMA 6-20R**] .

4. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

    a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Isolated Ground Duplex Straight-Blade Receptacle with Type 3 Surge Protective Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
    b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
    b. Configuration: Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

    a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner .
b. Configuration:

1) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-A ports.
2) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-C ports.
3) General-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; one USB-A port; one USB-C port.
4) General-duty, smooth face, two USB-A ports.
5) General-duty, smooth face, four USB-A ports.

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Wired Full-Controlled Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles with Integral Switching Means: UL CCN RTXI and UL Subject 498B.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

G. Wired Half-Controlled Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles with Integral Switching Means: UL CCN RTXI and UL Subject 498B.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.7 HOSPITAL-GRADE STRAIGHT-BLADE RECEPTACLES

A. Hospital-Grade, Non-Ferrous Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration: Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Leviton Manufacturing Co., Inc.**]
   c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
    b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
    b. Configuration:

        1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
        2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .
        3) Extra-heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
        4) Extra-heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

    a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Hospital-Grade, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
    b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance**

with NEMA WD 1][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

b. Configuration:

1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Hospital-Grade, Tamper-Resistant, Isolated Ground Duplex Straight-Blade Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Leviton Manufacturing Co., Inc.**]
b. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration:

1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .
2) Heavy-duty, smooth face, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Pass & Seymour; Legrand North America, LLC**]
   d. >

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
   b. Surge Protective Devices: UL 1449, Type 3.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration:

      1) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-A ports.
      2) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; two USB-C ports.
      3) Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] ; one USB-A port; one USB-C port.

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.8 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]

b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Outlet Branch-Circuit Type AFCIs: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI and GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Leviton Manufacturing Co., Inc.**]
c. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Outlet Branch-Circuit Type GFCIs and AFCIs: UL CCN KCXX, UL 498, UL 943, UL 1699, and UL Subject 1699A.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.

b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. General-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
    b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

    a. Cover Plate: **0.060 inch** **(1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Hospital-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Hospital-Grade, Isolated Ground, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton, Wiring Devices; Arrow Hart**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

3. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**] as directed by the Owner.
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**] .

4. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

5. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.9 LOCKING RECEPTACLES

A. UL RTRT - NEMA, 125 V, Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Electrification Installations Products**]
   b. [**Eaton, Wiring Devices; Arrow Hart**]
   c. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Leviton Manufacturing Co., Inc.**]
   e. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

   a. Device Color: Black with yellow voltage indication on face.
   b. Configuration: 2 pole, 3 wire, grounding, [**NEMA L5-15R**][**NEMA L5-20R**][**NEMA L5-30R**] .

B. UL RTRT - NEMA, 125 V, Isolated Ground Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton, Wiring Devices; Arrow Hart**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

    a. Device Color: Black with yellow voltage indication on face.
    b. Configuration: 2 pole, 3 wire, grounding, [**NEMA L5-15R**][**NEMA L5-20R**][**NEMA L5-30R**] .

C. UL RTRT - NEMA, 250 V, Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

    a. Device Color: Black with blue voltage indication on face.
    b. Configuration:

        1) 2 pole, 3 wire, grounding, [**NEMA L6-15R**][**NEMA L6-20R**][**NEMA L6-30R**] .
        2) 3 pole, 4 wire, grounding, [**NEMA L15-20R**][**NEMA L15-30R**] .
        3) 4 pole, 4 wire, non-grounding, [**NEMA L18-20R**][**NEMA L18-30R**] .
        4) 4 pole, 5 wire, grounding, [**NEMA L21-20R**][**NEMA L21-30R**] .

D. UL RTRT - NEMA, 250 V, Isolated Ground Locking Receptacle :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton, Wiring Devices; Arrow Hart**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or

more of the following guide information and corresponding standards:

a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.

4. Standard Features:

a. Device Color: Black with blue voltage indication on face.
b. Configuration:

1) 2 pole, 3 wire, grounding, [**NEMA L6-15R**][**NEMA L6-20R**][**NEMA L6-30R**] .
2) 3 pole, 4 wire, grounding, [**NEMA L15-20R**][**NEMA L15-30R**] .
3) 4 pole, 5 wire, grounding, [**NEMA L21-20R**][**NEMA L21-30R**] .

2.10 PIN-AND-SLEEVE RECEPTACLES

A. UL QLIW - C2 Series, 125/250 V, Pin-and-Sleeve Receptacles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
c. [**Eaton, Wiring Devices; Arrow Hart**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Pin-and-Sleeve Type Receptacles: UL CCN QLIW; including UL 1682.

4. Standard Features:

a. Series: UL 1686 Series C2 and IEC 60309-2 Series II.
b. Voltage Rating: 125/250 V.
c. Configuration:

1) 2 pole, 3 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A**] .
2) 3 pole, 4 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .
3) 4 pole, 5 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .

B. UL QLIW - C2 Series, 480 V, Pin-and-Sleeve Receptacles :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**ABB Electrification Installations Products**]
b. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
c. [**Eaton, Wiring Devices; Arrow Hart**]
d. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
f. [**Leviton Manufacturing Co., Inc.**]
g. [**Pass & Seymour; Legrand North America, LLC**]

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Pin-and-Sleeve Type Receptacles: UL CCN QLIW; including UL 1682.

4. Standard Features:

   a. Series: UL 1686 Series C2 and IEC 60309-2 Series II.
   b. Voltage Rating: 480 V.
   c. Configuration:

      1) 2 pole, 3 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A**] .
      2) 3 pole, 4 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .
      3) 4 pole, 5 wire, [**20 A**][**30 A, IP67**][**30 A, IP69k**][**60 A, IP67**][**60 A, IP69k**][**100 A, IP67**][**100 A, IP69k**] .

2.11 CORD REELS AND FITTINGS

A. Power Outlet Cord Management Assembly :

1. Source Limitations: Obtain all components for each power outlet cord management assembly from single manufacturer.
2. General Characteristics: Provide the following specified products with fabricated power outlet cord management assembly:

   a. Cord Management System:

      1) Spring-driven commercial/industrial-use cord reel .
      2) Cord reel for use in Class I Group D hazardous location .

   b. Termination Fitting:

      1) the Owner-furnished fitting.

      2) Outdoor-use, watertight, sealed cord connector;

3. Accessories:

   a. Mounting: [**Ceiling**][**Wall**][**Floor**] mounted.

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**] .

B. Spring-Driven Commercial/Industrial-Use Cord Reel, 14 AWG Conductors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Eaton**]
   b. [**Ericson Manufacturing Company**]
   c. [**Gleason Reel; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Cord and Cable Reels: UL CCN SBCV and UL 355.

3. Standard Features:

   a. Spring take-up retraction mechanism.

   b. Electrical Rating with Cable: 600 V, [**18 A**][**15 A**][**12 A**][**10.5 A**][**7.5 A**] .
   c. Color: [**Yellow**][**Black**][**White**].
   d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
   e. Ball stop.
   f. Pivot base.
   g. Spool Capacity:

      1) 14 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**][**70 ft (21.3 m)**] .

2) 14 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**35 ft (10.7 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**][**70 ft (21.3 m)**] .
3) 14 AWG, five wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**] .
4) 14 AWG, seven wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**] .
5) 14 AWG, nine wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**] .
6) 14 AWG, eleven wires and equipment ground, [**20 ft (6 m)**][**60 ft (18.3 m)**] .

7) 14 AWG, two wires and equipment ground, [**25 ft (7.6 m)**][**35 ft (10.7 m)**][**45 ft (13.7 m)**][**90 ft (27.4 m)**][**100 ft (30.5 m)**][**125 ft (38.1 m)**][**150 ft (45.7 m)**] .
8) 14 AWG, three wires and equipment ground, [**25 ft (7.6 m)**][**45 ft (13.7 m)**][**65 ft (19.8 m)**][**80 ft (24.4 m)**][**90 ft (27.4 m)**][**100 ft (30.5 m)**][**125 ft (38.1 m)**][**150 ft (45.7 m)**] .
9) 14 AWG, five wires and equipment ground, [**25 ft (7.6 m)**][**35 ft (10.7 m)**][**45 ft (13.7 m)**] .
10) 14 AWG, seven wires and equipment ground, [**25 ft (7.6 m)**][**35 ft (10.7 m)**][**45 ft (13.7 m)**] .
11) 14 AWG, nine wires and equipment ground, [**25 ft (7.6 m)**][**50 ft (15.2 m)**] .
12) 14 AWG, eleven wires and equipment ground, [**25 ft (7.6 m)**][**30 ft (9.1 m)**] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

C. Spring-Driven Commercial/Industrial-Use Cord Reel, 12 AWG Conductors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Appleton; Emerson Electric Co., Automation Solutions**]
   b. [**Ericson Manufacturing Company**]
   c. [**Gleason Reel; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   d. [**Reelcraft Industries Inc**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Cord and Cable Reels: UL CCN SBCV and UL 355.

3. Standard Features:

   a. Spring take-up retraction mechanism.

   b. Electrical Rating with Cable: 600 V, [**25 A**][**20 A**][**16 A**][**14 A**] .
   c. Color: [**Yellow**][**Black**][**White**].
   d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
   e. Ball stop.
   f. Pivot base.
   g. Spool Capacity:

      1) 12 AWG, two wires and equipment ground, [**20 ft (6 m)**][**25 ft (7.6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**] .
      2) 12 AWG, three wires and equipment ground, [**20 ft (6 m)**][**25 ft (7.6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**45 ft (13.7 m)**][**50 ft (15.2 m)**][**60 ft (18.3 m)**][**100 ft (30.5 m)**] .
      3) 12 AWG, five wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
      4) 12 AWG, seven wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**] .

      5) 12 AWG, two wires and equipment ground, [**35 ft (10.7 m)**][**45 ft (13.7 m)**][**70 ft (21.3 m)**][**80 ft (24.4 m)**][**90 ft (27.4 m)**][**100 ft (30.5 m)**][**125 ft (38.1 m)**][**150 ft (45.7 m)**] .
      6) 12 AWG, three wires and equipment ground, [**35 ft (10.7 m)**][**70 ft (21.3 m)**][**80 ft (24.4 m)**][**90 ft (27.4 m)**][**125 ft (38.1 m)**] .
      7) 12 AWG, four wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
      8) 12 AWG, five wires and equipment ground, [**25 ft (7.6 m)**][**35 ft (10.7 m)**][**45 ft (13.7 m)**] .
      9) 12 AWG, seven wires and equipment ground, [**25 ft (7.6 m)**][**40 ft (12.2 m)**] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

D. Spring-Driven Cord Reel for Use in Class I Group D Hazardous Locations :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Appleton; Emerson Electric Co., Automation Solutions**]
   b. [**Conductix-Wampfler USA; Delachaux Group**]
   c. [**KH Industries, Inc.**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Cord Reels for Use in Hazardous Locations: UL CCN SAOX and UL 355.

3. Standard Features:

   a. Spring take-up retraction mechanism.

   b. Electrical Rating with Cable: 600 V, [**35 A**][**25 A**][**20 A**][**18 A**][**15 A**] .
   c. Color: [**Yellow**][**Black**][**White**].
   d. Enclosure Degree of Protection: [**Type 4**][**Type 4X**] .
   e. Ball stop.
   f. Pivot base.
   g. Spool Capacity:

      1) 14 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**50 ft (15.2 m)**] .
      2) 14 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**50 ft (15.2 m)**] .
      3) 12 AWG, two wires and equipment ground, [**30 ft (9.1 m)**][**50 ft (15.2 m)**] .
      4) 14 AWG, two wires and equipment ground, [**40 ft (12.2 m)**][**60 ft (18.3 m)**][**70 ft (21.3 m)**] .
      5) 14 AWG, three wires and equipment ground, [**40 ft (12.2 m)**][**60 ft (18.3 m)**] .
      6) 12 AWG, two wires and equipment ground, [**20 ft (6 m)**][**40 ft (12.2 m)**][**60 ft (18.3 m)**] .
      7) 12 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**][**50 ft (15.2 m)**] .
      8) No. 10 AWG, two wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .
      9) No. 10 AWG, three wires and equipment ground, [**20 ft (6 m)**][**30 ft (9.1 m)**][**40 ft (12.2 m)**] .

4. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

   a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**and unit must be fully operational after seismic events**] ."

   b. Component Importance Factor (Ip): [**1.0**][**1.5**] .

   c. Component Amplification Factor (ap): [**1.0**][**2.5**].

   d. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**].

   e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**].

2.12 CONNECTORS, CORDS, AND PLUGS

A. Outdoor-Use, Watertight, Sealed Cord Connector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Ericson Manufacturing Company**]

2. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**FM Approvals**][**CSA Group (with "US" marking)**][**Intertek ETL**][**TÜV Rheinland**][**or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Fuseless Attachment Plugs: UL CCN AXUT and UL 498.

3. Standard Features:

a. Configuration:

1) NEMA 5-15 [**with diagnostic LED indicator**] .
2) NEMA 5-20 [**with diagnostic LED indicator**] .
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20 [**with diagnostic LED indicator**] .
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.
18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

2.13 MAINTENANCE MATERIAL ITEMS FOR STRAIGHT-BLADE RECEPTACLES

A. Extra Stock Material: Furnish to the Owner extra materials [**from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. [**Include the following:**]

1. SPD Receptacles: Equal to [**10**] percent of quantity installed for each kind specified, but no fewer than [**one**] units.
2. Controlled Receptacles: Equal to [**10**] percent of quantity installed for each kind specified, but no fewer than [**one**] units.

B. Special Tools: Furnish to the Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to controlled receptacles, that are packaged with protective covering for storage on-site and identified with labels describing contents.

2.14 MAINTENANCE MATERIAL ITEMS FOR CONNECTORS, CORDS, AND PLUGS

A. Extra Stock Material: Furnish to the Owner extra materials [**from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. [**Include the following:**]

1. Cord Connectors: [**One**] of each kind.

B. Special Tools: Furnish to the Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to cord connectors, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for the Owner-furnished equipment are compatible with mating attachment plugs on equipment.

B. Cord Reels and Fittings:

1. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.
2. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONTROLLED AND UNCONTROLLED RECEPTACLES

A. Private and Open Office Spaces:

1. Uncontrolled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one uncontrolled receptacle is selected for installation not greater than **6 ft. (1.8 m)** from each workstation.
2. Controlled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one controlled receptacle is selected for installation not greater than **6 ft. (1.8 m)** from each workstation.
3. Contact Architect for resolution of discrepancies between these requirements and Drawings, as directed by the Owner.

3.3 SELECTION OF GFCI RECEPTACLES

A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.4 INSTALLATION OF GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Life Safety and Means of Egress Work: NFPA 101.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Wiring Devices: NECA NEIS 130.
6. Mounting Heights: NECA NEIS 1.
7. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification:

a. Identify cover or cover plate for device with panelboard identification and circuit number.

b. Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.5 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.

11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.

1) Identify cover or cover plate for device with panelboard identification and circuit number.

2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

2. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.

3.6 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.

1) Identify cover or cover plate for device with panelboard identification and circuit number.

2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.7 INSTALLATION OF PIN-AND-SLEEVE RECEPTACLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in UL 1686.
11. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.

1) Identify cover or cover plate for device with panelboard identification and circuit number.

2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**] -filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.8 INSTALLATION OF CORD REELS AND FITTINGS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Hot Work: NFPA 51B.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

3.9 INSTALLATION OF CONNECTORS, CORDS, AND PLUGS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Work in ITE Rooms: NFPA 75.
6. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements, as directed by the Owner.

3.10 FIELD QUALITY CONTROL OF GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections in accordance with manufacturers' published instructions.

D. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.11 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.12 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.13 FIELD QUALITY CONTROL OF PIN-AND-SLEEVE RECEPTACLES

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]

as directed by the Owner.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Measure line voltage.
3. Measure percent voltage drop.
4. Measure ground impedance, which must be not greater than 2 ohms.
5. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.14 FIELD QUALITY CONTROL OF CORD REELS AND FITTINGS

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections indicated in manufacturer's published instructions.

D. Nonconforming Work:

1. Components and assemblies will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.15 FIELD QUALITY CONTROL OF CONNECTORS, CORDS, AND PLUGS

A. Administrant for Electrical Power Tests and Inspections:

1. [**the Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**] as directed by the Owner.

C. Tests and Inspections: Perform tests and inspections indicated in manufacturer's published instructions.

D. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.16 SYSTEM STARTUP FOR GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.17 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within [**12**] months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] visits to the Project during other-than-normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.18 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

B. Cord Reels and Fittings: After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

C. Connectors, Cords, and Plugs: After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the Owner.

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SECTION 26 27 26 00A - RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles with AFCI devices.
2. Receptacles with both AFCI and GFCI devices.
3. Receptacles with GFCI devices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies covers and cover plates referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
8. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles that are not hospital grade.
9. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for hospital-grade receptacles.
10. Section 262726.39 "Locking Receptacles" for twist-locking receptacles.
11. Section 262726.41 "Pin-and-Sleeve Receptacles" for pin-and-sleeve receptacles.

1.2 DEFINITIONS

A. AFCI: Arc-Fault Circuit Interrupter.

B. GFCI: Ground-Fault Circuit Interrupter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and

fitness for purpose.

b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.

c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

2. Include manufacturer's sample extended warranty language.

B. Samples:

1. One for each kind of receptacles with AFCI devices[**and cover plate accessory**] specified, in each finish and color specified.
2. One for each kind of receptacles with AFCI and GFCI devices[**and cover plate accessory**] specified, in each finish and color specified.
3. One for each kind of receptacles with GFCI devices[**and cover plate accessory**] specified, in each finish and color specified.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.5 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 RECEPTACLES WITH AFCI DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Outlet Branch-Circuit Type AFCIs: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Leviton Manufacturing Co., Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Leviton Manufacturing Co., Inc.**]
b. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Outlet Branch-Circuit Type AFCIs: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 RECEPTACLES WITH BOTH AFCI AND GFCI DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI and GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Outlet Branch-Circuit Type GFCIs and AFCIs: UL CCN KCXX, UL 498, UL 943, UL 1699, and UL Subject 1699A.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.4 RECEPTACLES WITH GFCI DEVICES

A. General-Grade Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]
    e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
    b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

    a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]

b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
    b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

    a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. General-Grade, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]
    e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. General-Grade, Weather-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on**

architectural Drawings].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

G. General-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth

finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

H. General-Grade, Isolated Ground, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

I. General-Grade, Isolated Ground, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade

Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Pass & Seymour; Legrand North America, LLC**]
    e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

    a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
    b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

    a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

    a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

J. Hospital-Grade Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

K. Hospital-Grade, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]

e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

L. Hospital-Grade, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

M. Hospital-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]

d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

N. Hospital-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

O. Hospital-Grade, Isolated Ground, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Pass & Seymour; Legrand North America, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].
   b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

   a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

   a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

P. Hospital-Grade, Isolated Ground, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Arrow Hart, Wiring Devices; Eaton, Electrical Sector**]
   b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Pass & Seymour; Legrand North America, LLC**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.

4. Standard Features:

   a. Device Color: [**Ivory**][**White**][**Gray**][**Brown**][**Black**][**Red**][**Yellow**][**Orange**][**in accordance with NEMA WD 1**][**Blue**][**Green**][**Office White**][**Almond**][**Light Almond**][**As indicated on architectural Drawings**].

b. Configuration: Heavy-duty, [**NEMA 5-15R**][**NEMA 5-20R**].

5. Other Available Features Required by the Project:

a. Has factory-terminated connectors on wiring device pigtails for quick installation.

6. Accessories:

a. Cover Plate: **0.060 inch (1.5 mm)** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 SELECTION OF GFCI RECEPTACLES

A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.3 INSTALLATION

A. Comply with manufacturer's instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Work in ITE Rooms: NFPA 75.
5. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installing and Maintaining Wiring Devices: NECA NEIS 130.
9. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
10. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.

11. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.

1) Identify cover or cover plate for device with panelboard identification and circuit number.
2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [**black**][**white**][**red**]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

2. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
3. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

4. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.

2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.
8. <**Insert tests and inspections**>.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 PROTECTION

A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 27 26 00A

SECTION 26 27 26 00B - CONNECTORS, CORDS, AND PLUGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fuseless attachment cord connectors.
2. Extra-hard-usage, jacketed, flexible cord.
3. Antimicrobial, extra-hard-usage, jacketed, flexible cord.
4. Hard-usage, jacketed, flexible cord.
5. Strain-relief cord grips.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 262726.43 "Special-Purpose Power Outlet Assemblies" specifies fabricated power-outlet cord management assemblies containing connectors and cords specified by this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: One for each kind of cord connector specified, in each finish and color specified.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSELESS ATTACHMENT CORD CONNECTORS

A. Description: Connectors for attachment to cord that do not incorporate switches or overcurrent protection.

B. Indoor-Use, Dry Location Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ericson Manufacturing Company**]
    b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

    a. Configuration: NEMA 5-15[**with lighted blade**].

C. Indoor-Use, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ericson Manufacturing Company**]
    b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

    a. Configuration:

1) NEMA 5-15[**with diagnostic LED indicator**].
2) NEMA 5-20[**with diagnostic LED indicator**].
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20[**with diagnostic LED indicator**].
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.
18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

D. Hospital-Grade, Indoor-Use, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ericson Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

   a. Configuration: [**NEMA 5-15**][**NEMA 5-20**].

E. Indoor-Use, Compression-Grip, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ericson Manufacturing Company**]
   b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

a. Configuration:

1) NEMA 5-15[**with diagnostic LED indicator**].
2) NEMA 5-20[**with diagnostic LED indicator**].
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20[**with diagnostic LED indicator**].
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.

F. Outdoor-Use, Watertight, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ericson Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN AXUT and UL 498.

3. Standard Features:

a. Configuration:

1) NEMA 5-15[**with diagnostic LED indicator**].
2) NEMA 5-20[**with diagnostic LED indicator**].
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20[**with diagnostic LED indicator**].
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.

18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

G. Antimicrobial, Watertight, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ericson Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN AXUT and UL 498.

3. Options:

a. Antimicrobial additive embedded in connector grip polymer.
b. Configuration:

1) NEMA 5-15.
2) NEMA 5-20.
3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20.
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.
18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

2.3 EXTRA-HARD-USAGE, JACKETED, FLEXIBLE CORD

A. Oil-Resistant, Extra-Hard-Usage, Jacketed, Flexible Cord for Indoor Damp Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Belden Inc.**]
b. [**Ericson Manufacturing Company**]
c. [**Southwire Company, LLC**]
d. [**U.S. Wire & Cable Corp.**]
e. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

a. 600 V, 90 deg C, hard service cord with oil-resistant jacket[**and oil-resistant insulation**] for pendant or portable extra-hard usage in damp locations.
b. Flexible Cord Type: [**STO**][**STOO**][**SEO**][**SEOO**][**SO**][**SOO**].

B. Oil-Resistant, Extra-Hard-Usage, Jacketed, Flexible Cord for Outdoor or Indoor Wet Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Ericson Manufacturing Company**]
c. [**Southwire Company, LLC**]
d. [**U.S. Wire & Cable Corp.**]
e. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

a. 600 V, 90 deg C, hard service cord with oil-resistant jacket[**and oil-resistant insulation**] for pendant or portable extra-hard usage in damp locations.
b. Flexible Cord Type: [**STOW**][**STOOW**][**SEOW**][**SEOOW**][**SOW**][**SOOW**].

2.4 ANTIMICROBIAL, EXTRA-HARD-USAGE, JACKETED, FLEXIBLE CORD

A. Antimicrobial, Oil-Resistant, Extra-Hard-Usage, Jacketed, Flexible Cord for Outdoor or Indoor Wet Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Ericson Manufacturing Company**]
b. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

a. 600 V, 90 deg C, hard service cord with oil-resistant jacket for pendant or portable extra-hard usage in damp or wet locations.
b. Antimicrobial additive embedded in jacket polymer.
c. Flexible Cord Type: [**STOW**][**SEOW**].
d. Configuration:

1) No. 14 AWG, two wires and equipment ground.
2) No. 12 AWG, two wires and equipment ground.
3) No. 12 AWG, three wires and equipment ground.
4) No. 10 AWG, two wires and equipment ground.
5) No. 10 AWG, three wires and equipment ground.

2.5 HARD-USAGE, JACKETED, FLEXIBLE CORD

A. Oil-Resistant, Hard-Usage, Jacketed, Flexible Cord for Indoor Damp Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Ericson Manufacturing Company**]
c. [**Southwire Company, LLC**]
d. [**U.S. Wire & Cable Corp.**]
e. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

a. 300 V, 90 deg C, hard service cord with oil-resistant jacket[**and oil-resistant insulation**] for pendant or portable extra-hard usage in damp locations.
b. Flexible Cord Type: [**SJTO**][**SJTOO**][**SJEO**][**SJEOO**][**SJO**][**SJOO**].

B. Oil-Resistant, Hard-Usage, Jacketed, Flexible Cord for Outdoor or Indoor Wet Locations:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Ericson Manufacturing Company**]
    c. [**Southwire Company, LLC**]
    d. [**U.S. Wire & Cable Corp.**]
    e. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Reference Standards: UL CCN ZJCZ and UL 62.

3. Standard Features:

    a. 300 V, 90 deg C, hard service cord with oil-resistant jacket[**and oil-resistant insulation**] for pendant or portable extra-hard usage in damp locations.
    b. Flexible Cord Type: [**SJTOW**][**SJTOOW**][**SJEOW**][**SJEOOW**][**SJOW**][**SJOOW**].

2.6 STRAIN-RELIEF CORD GRIPS

A. Strain-Relief Cord Grip:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Ericson Manufacturing Company**]
    b. [**Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    c. [**Pass & Seymour; Legrand North America, LLC**]
    d. <**Insert manufacturer's name**>

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Reference Standards: UL CCN QCRV and UL 514B.

3. Standard Features:

    a. Strain-relief grip for bus drop cable.
    b. Noninsulated strain-relief grip for flexible cord.
    c. Insulated strain-relief grip for flexible cord.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Work in ITE Rooms: NFPA 75.
6. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' instructions**>.

D. Interfaces with Other Work:

1. Coordinate with Section 262726.43 "Special-Purpose Power Outlet Assemblies" for installation of connectors and cords on fabricated power-outlet cord management assemblies.
2. Coordinate installation of new products for <**Insert system or product group**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.2 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform tests and inspections indicated in manufacturer's instructions.
2. <**Insert Project-specific test or inspection**>.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

END OF SECTION 26 27 26 00B

Task	Specification	Specification Description
26 27 26 00	26 09 23 00	Electrical Power Monitoring

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SECTION 26 27 33 00 - POWER DISTRIBUTION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured power distribution units.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Reinstalled" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. EPO: Emergency power-off.

B. SPD: Surge protective device.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For power distribution units. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives of Owner, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.
2. Coordinate layout and installation of power distribution units with Owner's equipment.

3. Record agreements reached in meetings and distribute record to other participants.
4. Adjust arrangements and locations of power distribution units to accommodate and optimize arrangement and space requirements of equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

B. Shop Drawings: Prepare and submit the following:

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Factory test reports.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Manufacturer's field reports for field quality-control support.

C. Manufacturer's field reports for system startup support.

D. Field reports for infrared scanning.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able

to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Usual Service Conditions: Unless unusual service conditions have been specified in "General Environmental Conditions," "Outdoor Conditions," and "Indoor Conditions" articles of Section 018116 "Facility Environmental Requirements," electrical service and distribution equipment must be suitable for operation under usual service conditions specified in applicable NEMA PB series, IEEE C37 series, and IEEE C57 series standards.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND REINSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.4 MANUFACTURED POWER DISTRIBUTION UNITS

A. Source Quality Control:

1. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate power distribution units.
c. Factory Tests and Inspections: Test and inspect power distribution units, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with referenced standards before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

1) Conduct factory sound-level tests.

d. Nonconforming Work:

1) Equipment that does not pass tests and inspections will be considered defective.

e. Factory Test Reports: Compile and submit factory test and inspection reports.

B. Power Distribution Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Liebert; Vertiv Holdings Co.**]
d. [**Myers Power Products, Inc**]
e. [**Power Distribution, Inc.; Eaton, Electrical Sector**]
f. [**Powersmiths International Corp.; Socomec Group**]
g. [**Square D; Schneider Electric USA**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Electrification Business**]
b. [**Eaton**]
c. [**Liebert; Vertiv Holdings Co.**]
d. [**Myers Power Products, Inc**]

e. [**Power Distribution, Inc.; Eaton, Electrical Sector**]
f. [**Powersmiths International Corp.; Socomec Group**]
g. [**Square D; Schneider Electric USA**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Standard Features:

a. Integrated and coordinated assembly of power-line-conditioning and distribution components packaged in single cabinet or modular assembly of cabinets[**each with full-swivel casters mounted to bottom frame**]. Include the following components:

1) Input-power, circuit-breaker section.
2) Isolation transformer.
3) SPD system.
4) Output panelboard(s).
5) Alarm, monitoring, and control system.

b. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
c. Wiring Access: [**Top**][**and**][**bottom**] wiring access.
d. Unit Capacity Rating: Carry indicated RMS kilovolt-ampere load continuously without affecting normal operation of circuit breakers, monitoring system, or unit controls and without exceeding rated insulation temperature for the following input voltage and load current:

1) Input Voltage: Within rated input-voltage tolerance band of unit.
2) Load Current: Minimum of 3.0 crest factor and 85 percent total harmonic distortion.

e. Input-Power, Circuit-Breaker Section: Three-pole, [**shunt-tripped,**]thermal-magnetic-type circuit breaker, rated for indicated interrupting capacity and 125 percent of input current of unit at 100 percent rated load at unit capacity rating.

1) Dual-Input Units:

a) Two input circuit breakers arranged to provide transfer between two input-power sources.
b) Controls and interfaces to allow selecting either open- or closed-transition transfer between two input-power sources.
c) Use 120 V permissive signal from both upstream voltage sources to indicate acceptable conditions for closed-transition transfer.
d) Open second circuit breaker automatically after closed-transition transfer is completed.

2) Static Transfer Switch: Three-pole, double-throw; solid-state, automatic transfer switch.

f. Isolation Transformer Section: Dry-type, electrostatically shielded, three-phase, common-core, convection-air-cooled isolation transformer.

1) Comply with UL 1561[**including requirements for nonsinusoidal load-current-handling capability defined by designated K-factor**].
2) Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses, one leg per phase.
3) Coil Material and Insulation: [**Aluminum**][**Copper**] windings, 220 deg C insulation

class.

4) Temperature Rise: Designed for [**80**][**115**][**150**] deg C rise above 40 deg C ambient.
5) Output Impedance: 3.5 plus or minus 0.5 percent.
6) Regulation: 2 to 4 percent maximum, at full-resistive load; 5 percent maximum, at rated nonlinear load.
7) Taps: Six full-capacity compensation taps at 2.5 percent increments; two above and four below nominal voltage.
8) Full-Load Efficiency: Minimum 96 percent at rated[**nonlinear**] load.
9) Magnetic-Field Strength External to Transformer Enclosure: Less than 0.1 G at **18 inch (450 mm)**.
10) K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

    a) Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
    b) Indicate value of K-factor on transformer nameplate.

11) Electrostatic Shielding: Independently shield each winding with full-width, [**single**][**double**], copper, electrostatic shield arranged to minimize interwinding capacitance.

    a) Coil leads and terminal trips must be arranged to minimize capacitive coupling between input and output connections.
    b) Shield Terminal: Separate, and marked "Shield" for grounding connection. Shield must be connected to reference ground point for distribution panels.
    c) Capacitance: Limit capacitance between primary and secondary windings to maximum of 33 pF over frequency range of 20 Hz to 1 MHz.
    d) Common-Mode Noise Attenuation: 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.
    e) Normal-Mode Noise Attenuation: 52 dB minimum, 1.5 to 10 kHz.

12) Neutral Rating: [**1.732 times**][**200 percent of**] system full-load ampere rating.
13) Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

g. SPD System: Integrated SPD system, complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," to protect unit panelboard, and having the following features:

1) Disconnect Device: Manual, three-pole, fused disconnect switch to de-energize SPD system while permitting power distribution units to continue operation. Fuses must be rated for 200 kA interrupting capacity.
2) Nonlinear Loading: System must accommodate rated-load current with minimum 3.0 crest factor and 85 percent total harmonic distortion.

h. Output Panelboards: Panelboards complying with Section 262416 "Panelboards" except for mounting provisions. Mount [**single**][**double**] panelboards on power distribution unit behind flush doors. Include the following features:

1) Construction: [**30**][**42**] pole, [**208 V**][**240 V**], three phase; capable of accepting branch circuit breakers rated up to 100 A.
2) Panelboard Rating: [**225 A**]<**Insert value**>, with main circuit breaker.
3) Panelboard Phase, Neutral, and Ground Buses: Copper, with neutral bus at least

[**1.732**][**two**] times nominal phase bus rating.

4) Isolated Ground Bus: Copper, adequate for branch-circuit equipment ground conductors; insulated from supports.
5) Branch Circuit Breakers: [**Bolt**][**Plug**] on.
6) Cable Racks: Removable and arranged for supporting and routing cables for panelboard entrance.
7) Access Panels: Arranged so additional branch-circuit wiring can be installed and connected in future.

i. Power Distribution Unit Controls: Include the following control features:

1) EPO switch integral with power distribution unit.
2) Power-off input terminals for connection to remote EPO switch.
3) Shutdown with automatic unit disconnection for the following alarm conditions:

a) High temperature in transformer coil.
b) High or low input or output voltage.
c) Phase loss.
d) Ground fault.
e) Reverse-phase rotation.

4) Alarm Contacts: Electrically isolated, Form C (one normally open and one normally closed), summary alarm; contact set must change state if monitored function goes into alarm mode.
5) Auxiliary Control Outputs: <**Insert control function outputs**>.

j. Monitoring, Status, and Alarm Annunciation: Microprocessor-based monitoring, status, and alarm annunciation panel mounted flush in front of power distribution unit to provide status display and failure-indicating interface for the following:

1) Power Monitoring:

a) Input Voltage: Line-to-line, RMS.
b) Output Voltage: Line-to-line and line-to-neutral, RMS.
c) Output current.

2) Status Indication: Unit on.
3) Alarm Annunciation:

a) High temperature in transformer coil.
b) High and low input voltage.
c) High and low output voltage.
d) Phase loss.
e) Ground fault.
f) Frequency.
g) Phase rotation.
h) SPD module failure.

4) Audible Alarm and Silencing Switch: Alarm sounds when alarm indication occurs. Silencing switch must silence audible alarm but leave visual indication active until alarm condition is corrected.

k. Sound Level:

1) Fully assembled products must have average audible sound levels[**more than 3 dB**] below the following maximum sound levels, without fans running, when factory

tested in accordance with IEEE C57.12.91:

a) 9 kVA and Smaller: [**40**]<**Insert number**> dB(A-weighted).
b) 9.01 to 30 kVA: [**45**]<**Insert number**> dB(A-weighted).
c) 30.01 to 50 kVA: [**45**][**48**]<**Insert number**> dB(A-weighted).
d) 50.01 to 150 kVA: [**50**][**53**]<**Insert number**> dB(A-weighted).
e) 150.01 to 300 kVA: [**55**][**58**]<**Insert number**> dB(A-weighted).
f) 300.01 to 500 kVA: [**60**][**63**]<**Insert number**> dB(A-weighted).
g) 500.01 to 700 kVA: [**62**][**65**]<**Insert number**> dB(A-weighted).
h) 700.01 to 1000 kVA: [**64**][**67**]<**Insert number**> dB(A-weighted).

2) Mount transformer on rubber isolation pads.

l. Enclosure:

1) Single, freestanding, galvanized steel, UL 50E Type 1 enclosure. Opening of exterior door may not provide access to live parts. Panels and covers that expose hazardous voltages must require tools to remove.
2) Access from front, top, and side only for installation, operations, and normal maintenance, including infrared scanning of bus and breakers. Normal operating controls and instrumentation must be located on front of enclosure.
3) Arrange enclosure to allow lifting and moving via forklift.

m. Finish: Manufacturer's standard finish over corrosion-resistant pretreatment and primer.

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**6.0**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**2.5**]<**Insert value**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in ITE Rooms: NFPA 75.
7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.

9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Connections to Connectors and Terminals: Comply with torque-tightening values in UL 486A-486B.
11. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Arrange power distribution units to provide adequate access to equipment and circulation of cooling air. Locate transformers away from corners and not parallel to adjacent wall surface.

D. Interfaces with Other Work:

1. Identification: Provide labels for power distribution units and associated electrical equipment.

   a. Identify field-installed conductors, interconnecting wiring, and components.
   b. Label each enclosure with engraved metal or laminated-plastic nameplate.
   c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Coordinate size and location of [**concrete bases**][**access flooring support**] with actual power distribution unit provided.
3. Equipment Mounting:

   a. Provide cast-in-place concrete equipment base(s) for equipment.
   b. Provide vibration isolation and seismic control devices for equipment.
   c. Supports must penetrate and be independent of access flooring.

4. Ground and bond power distribution unit.
5. Install flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.2 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for circuit

breakers, molded case; and for transformers, dry type, air cooled, low voltage. Certify compliance with test parameters.
3. Perform functional tests of power distribution units throughout their operating ranges. Test each monitoring, status, and alarm function.
4. Test Labeling: On completion of satisfactory testing of each unit, attach dated and signed "Satisfactory Test" label to tested component.

E. Nonconforming Work:

1. Power distribution unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.3 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Verify that power distribution units are installed and connected in accordance with the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal and with published installation requirements in other electrical Sections.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Adjust power distribution units to provide optimal voltage to equipment served throughout normal operating cycle of loads served. Record input and output voltages and adjustment settings, and incorporate into test results.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain power distribution units.

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

3.7 PROTECTION

A. After installation, protect power distribution units from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Infrared Scanning of Power Distribution Units: Two months after Substantial Completion, perform infrared scan of conductor and bus joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of power distribution units, one at four months and another at 11 months after Substantial Completion.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Field Reports for Infrared Scanning: Prepare certified report that identifies joints and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 27 33 00

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Task	Specification	Specification Description
26 27 73 00	26 27 26 00	Wiring Devices

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SECTION 26 28 13 00 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonrenewable cartridge fuses.
2. Spare-fuse cabinets.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 260573 "Power System Studies" specifies coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit [**in electronic format suitable for use in coordination software**][**and**][**in PDF format**].
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Extra stock material.

1.4 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than [**40 deg F (5 deg C)**]<**Insert temperature**> or more than [**100 deg F (38 deg C)**]<**Insert temperature**>, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 NONRENEWABLE CARTRIDGE FUSES

A. Class CC Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bussmann, an Eaton business**]
    b. [**Edison; a brand of Bussmann by Eaton**]
    c. [**Littelfuse, Inc.**]
    d. [**Mersen USA**]
    e. [**Optifuse; Vortex Technologies; division of Triad Partners, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bussmann, an Eaton business**]
    b. [**Edison; a brand of Bussmann by Eaton**]
    c. [**Littelfuse, Inc.**]
    d. [**Mersen USA**]
    e. [**Optifuse; Vortex Technologies; division of Triad Partners, LLC**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-4 (Class CC).

5. Standard Features:

a. NEMA FU 1, Class CC, 200 kA(sym) interrupt rating, current limiting, sizes up to 30 A, 600 V(ac), [**12 s minimum time-delay at 200 percent**][**non-time-delay**], with rejection feature.

B. Class CD Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Littelfuse, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Littelfuse, Inc.**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-18 (Class CD).

5. Standard Features:

   a. UL 248-18, Class CD, 200 kA(sym) interrupt rating, current limiting, sizes 31 to 60 A, 600 V(ac), [**12 s minimum time-delay at 200 percent**][**non-time-delay**], with rejection feature.

C. Class J Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-8 (Class J).

5. Standard Features:

    a. NEMA FU 1, Class J, [**200 kA(sym)**][**300 kA(sym)**] interrupt rating, current limiting, sizes up to 600 A, 600 V(ac), [**8 to 10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature.

D. Class L Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bussmann, an Eaton business**]
    b. [**Edison; a brand of Bussmann by Eaton**]
    c. [**Littelfuse, Inc.**]
    d. [**Mersen USA**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bussmann, an Eaton business**]
    b. [**Edison; a brand of Bussmann by Eaton**]
    c. [**Littelfuse, Inc.**]
    d. [**Mersen USA**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-10 (Class L).

5. Standard Features:

    a. NEMA FU 1, Class L, 300 kA(sym) interrupt rating, current limiting, sizes 100 to 6000 A, 600 V(ac), [**4 s minimum time-delay (nonstandard) at 500 percent**][**10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature, with bolt-on terminals.

E. Class RK1 Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Bussmann, an Eaton business**]
b. [**Edison; a brand of Bussmann by Eaton**]
c. [**Littelfuse, Inc.**]
d. [**Mersen USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bussmann, an Eaton business**]
b. [**Edison; a brand of Bussmann by Eaton**]
c. [**Littelfuse, Inc.**]
d. [**Mersen USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-12 (Class R).

5. Standard Features:

a. NEMA FU 1, Class RK1, 200 kA(sym) interrupt rating, current limiting, sizes up to 600 A, [**250 V(ac)**][**600 V(ac)**], [**8 to 10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature.

1) Select ferrule terminals or knife blade terminals to match equipment where fuse is installed.

F. Class RK5 Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bussmann, an Eaton business**]
b. [**Edison; a brand of Bussmann by Eaton**]
c. [**Littelfuse, Inc.**]
d. [**Mersen USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bussmann, an Eaton business**]
b. [**Edison; a brand of Bussmann by Eaton**]
c. [**Littelfuse, Inc.**]

d. [**Mersen USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-12 (Class R).

5. Standard Features:

   a. NEMA FU 1, Class RK5, 200 kA(sym) interrupt rating, current limiting, sizes up to 600 A, [**250 V(ac)**][**600 V(ac)**], [**8 to 10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature.

      1) Select ferrule terminals or knife blade terminals to match equipment where fuse is installed.

G. Class T Nonrenewable Cartridge Fuse :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. [**Optifuse; Vortex Technologies; division of Triad Partners, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bussmann, an Eaton business**]
   b. [**Edison; a brand of Bussmann by Eaton**]
   c. [**Littelfuse, Inc.**]
   d. [**Mersen USA**]
   e. [**Optifuse; Vortex Technologies; division of Triad Partners, LLC**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-15 (Class T).

5. Standard Features:

a. NEMA FU 1, Class T, 200 kA(sym) interrupt rating, current limiting, sizes up to 1200 A, [**300 V(ac)**][**600 V(ac)**], [**8 to 10 s minimum time-delay at 500 percent**][**non-time-delay**], with rejection feature.

1) Select ferrule terminals or knife blade terminals to match equipment where fuse is installed.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with [**15**]<**Insert number**> percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

2.4 MAINTENANCE MATERIAL ITEMS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FUSES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Work in Confined Spaces: NFPA 350.
5. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
6. Fuse Applications: NECA NEIS 420.
7. Work with Fuses in Motor Control Centers: NECA NEIS 402.

C. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

D. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

E. Install spare-fuse cabinet(s) in location indicated on the Drawings or as indicated in the field by [**Architect**][**Construction Manager**][**Owner**].

F. Interfaces with Other Work:

1. Identification: Provide labels for spare fuse cabinet.

   a. Legend: "SPARE FUSES" in **1-1/2 inch (38 mm)** high letters on exterior of door.

2. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with results of coordination study and arc-flash hazard analysis.

END OF SECTION 26 28 13 00

Task	Specification	Specification Description
26 28 13 00	26 11 16 11	Secondary Unit Substations with Switchgear Secondary

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SECTION 26 28 16 00 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Enclosed Switches:

a. UL WIAX or NITW - Single- or double-throw enclosed switch.
b. UL WIAX or NITW - Fused electrically-tripped enclosed switch.
c. UL WIAX or NITW - Electrically-tripped ground-fault protection enclosed switch.

2. Dead-Front Switches:

a. UL WHXS - Switch for mounting in separate dead-front enclosure.

3. Enclosed Switches for Use in Hazardous (Classified) Locations:

a. UL WRPR - Enclosed switch for use in hazardous location.

4. Fused Power-Circuit Devices:

a. UL IYSR - Enclosed fused bolted-pressure contact switch.
b. UL IYSR - Enclosed fused high-pressure butt-type contact switch.

5. Molded-Case Circuit Breakers and Enclosures:

a. UL DIVQ - Enclosed molded-case circuit breaker.

6. Molded-Case Switches and Enclosures:

a. UL WJAZ - Enclosed molded-case switch.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding electrical equipment including raceways, electrical power cabling, and communications cabling referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic- [**and wind-**] control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and

warning signs referenced by this Section.

8. Section 260573 "Power System Studies" specifies short-circuit current analysis, coordination study, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. GFCI: Ground-fault circuit interrupter.

C. MCCB: Molded-case circuit breaker.

D. N.C.: Normally closed.

E. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

F. N.O.: Normally open.

G. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.
2. Include manufacturer's sample extended warranty language.
3. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
4. Enclosure types and details for types other than UL 50E, Type 1.
5. Current and voltage ratings.
6. Short-circuit current ratings (interrupting and withstand, as appropriate).
7. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
9. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in [**PDF**][**and**]<**Insert calculation program format**> electronic format.

B. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents for Enclosed Switches and Circuit Breakers:

a. Include plans, elevations, sections, details, and attachments to other work.
b. Include wiring diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

1.7 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for electrical Work specified in this Section must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria" unless otherwise specified in this Section or on the Drawings.

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Three**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Enclosures:

1. Enclosed Switches and Circuit Breakers: UL 489, NEMA BS 31047, UL 50E, and UL 50, to comply with environmental conditions at installed location.
2. Enclosure Finish: Enclosure must be [**finished with**][**gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1)**][**gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (UL 50E Types 3R, 12)**][**a brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel)**][**copper-free cast aluminum alloy (UL 50E Types 7, 9)**] .
3. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
4. Operating Mechanism: Circuit-breaker operating handle must be [**externally operable with operating mechanism being integral part of box, not cover**][**directly operable through front cover of enclosure (UL 50E Type 1)**][**directly operable through dead front trim of enclosure (UL 50E Type 3R)**][**externally operable with operating mechanism being integral part of cover (UL 50E Types 7, 9)**] . Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
5. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
6. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

D. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events [**, and unit must be fully operational after seismic events**] .
2. Component Importance Factor (Ip): [**1.0**][**1.5**] .
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**> .
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**> .
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**> .

2.2 ENCLOSED SWITCHES

A. UL WIAX or NITW - Single- or Double-Throw Enclosed Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Industrial Connections & Solutions LLC**]
   b. [**ABB Industrial Connections and Solutions LLC (Tradename Midwest)**]
   c. [**Appleton; Emerson Electric Co., Automation Solutions**]
   d. [**Bussmann; Eaton, Electrical Sector**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**Eaton**]
   g. [**Hubbell Inc Wiring Device Div**]
   h. [**Leviton Manufacturing Co., Inc.**]
   i. [**Siemens**]
   j. [**Square D; Schneider Electric USA**]
   k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Industrial Connections & Solutions LLC**]
   b. [**ABB Industrial Connections and Solutions LLC (Tradename Midwest)**]
   c. [**Appleton; Emerson Electric Co., Automation Solutions**]
   d. [**Bussmann; Eaton, Electrical Sector**]
   e. [**Crouse-Hinds; brand of Eaton, Electrical Sector**]
   f. [**Eaton**]
   g. [**Hubbell Inc Wiring Device Div**]
   h. [**Leviton Manufacturing Co., Inc.**]
   i. [**Siemens**]
   j. [**Square D; Schneider Electric USA**]
   k. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Listed Enclosed Switches: UL CCN WIAX, including UL 98.

b. Listed Industrial Control Panels: UL CCN NITW, including UL 508A for entire assembly and UL 98 component certification for switches.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches must be marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
h. Poles: [**Two**][**Three**][**Four**] .
i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
l. Fusing: [**Fused**][**Nonfused**] .
m. Load Class: [**General**][**Isolating**] Use.
n. Throw: [**Single**][**Double**] .

6. Accessories:

a. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

1) Interlocking Linkage: Provide interlock between receptacle and switch mechanism to prevent inserting or removing plug while switch is in on position, while inserting plug other than specified, and while turning switch on if incorrect plug is inserted or correct plug has not been fully inserted into receptacle.

b. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
c. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
d. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
e. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
f. Service-Rated Switches: Labeled for use as service equipment.
g. Hookstick Handle: Allows use of hookstick to operate handle.
h. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
i. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

B. UL WIAX or NITW - Fused Electrically-Tripped Enclosed Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following] :

a. [**Eaton**]
b. [**Mersen USA**]
c. [**Siemens**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Mersen USA**]
c. [**Siemens**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Listed Enclosed Switches: UL CCN WIAX, including UL 98.
b. Listed Industrial Control Panels: UL CCN NITW, including UL 508A for entire assembly and UL 98 component certification for switches.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches must be marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Shunt Trip: Comply with [**ASME A17.1,**] UL 50E, and UL 98, with Class J fuse block and 200 kA interrupting and short-circuit current rating.
h. Shunt Trip Control Circuit: 120 V(ac); obtained from [**integral control power transformer, with primary and secondary fuses,**]<**Insert source of control power**> with control power [**transformer**][**source**] of enough capacity to operate shunt trip, pilot, indicating and control devices.
i. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
j. Poles: [**Two**][**Three**][**Four**] .
k. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
l. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
m. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
n. Fusing: [**Fused**][**Nonfused**] .
o. Load Class: [**General**][**Isolating**] Use.
p. Throw: [**Single**][**Double**] .

6. Accessories:

    a. Elevator Disconnect Accessories:

        1) Oiltight key switch for key-to-test function.
        2) Oiltight Pilot Light: [**Red**][**Green**][**White**][**Yellow**] ON.
        3) Isolated Neutral Lug: [**100**][**200**] percent rating.
        4) Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
        5) Three-pole, double-throw, fire-safety and alarm relay: [**120 V(ac)**][**24 V(dc)**] coil voltage.
        6) Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

    b. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
    c. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
    d. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
    e. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
    f. Service-Rated Switches: Labeled for use as service equipment.
    g. Hookstick Handle: Allows use of hookstick to operate handle.
    h. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
    i. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

C. UL WIAX or NITW - Electrically-Tripped Ground-Fault Protection Enclosed Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton**]
    b. [**Mersen USA**]
    c. [**Siemens**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]
    b. [**Mersen USA**]
    c. [**Siemens**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Listed Enclosed Switches: UL CCN WIAX, including UL 98.
b. Listed Industrial Control Panels: UL CCN NITW, including UL 508A for entire assembly and UL 98 component certification for switches.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches must be marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Shunt Trip: Comply with UL 50E, and UL 98, with Class J fuse block and 200 kA interrupting and short-circuit current rating.
h. Shunt Trip Control Circuit: 120 V(ac); obtained from [**integral control power transformer, with primary and secondary fuses,**]<**Insert source of control power**> with control power [**transformer**][**source**] of enough capacity to operate shunt trip, pilot, indicating and control devices.
i. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
j. Poles: [**Two**][**Three**][**Four**] .
k. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
l. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
m. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
n. Fusing: [**Fused**][**Nonfused**] .
o. Load Class: [**General**][**Isolating**] Use.
p. Throw: [**Single**][**Double**] .

6. Accessories:

a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
e. Service-Rated Switches: Labeled for use as service equipment.
f. Hookstick Handle: Allows use of hookstick to operate handle.
g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

2.3 DEAD-FRONT SWITCHES

A. UL WHXS - Switch for Mounting in Separate Dead-Front Enclosure :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

a. [**Eaton**]
b. [**Erickson Electrical Equipment Company**]
c. [**Siemens**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Erickson Electrical Equipment Company**]
c. [**Siemens**]
d. [**Square D; Schneider Electric USA**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

a. Listed Dead-Front Switches: UL CCN WHXS, including UL 98.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
h. Poles: [**Two**][**Three**][**Four**] .
i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
l. Fusing: [**Fused**][**Nonfused**] .
m. Load Class: [**General**][**Isolating**] Use.
n. Throw: [**Single**][**Double**] .

6. Accessories:

a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground

conductors.
b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
e. Service-Rated Switches: Labeled for use as service equipment.
f. Hookstick Handle: Allows use of hookstick to operate handle.
g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

2.4 ENCLOSED SWITCHES FOR USE IN HAZARDOUS (CLASSIFIED) LOCATIONS

A. UL WRPR - Enclosed Switch for Use in Hazardous Location :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**Appleton Group (tradename NEER)**]
   b. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Rockwell Automation, Inc.**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Appleton Group (tradename NEER)**]
   b. [**Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   c. [**Rockwell Automation, Inc.**]
   d. [**Square D; Schneider Electric USA**]
   e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

   a. Listed Enclosed Switches: UL CCN WRPR, including UL 98.
   b. Listed Equipment for Use in and Relating to Classes I, II, and III, Divisions 1 and 2 Hazardous Locations: UL CCN AAIZ, including one or more of the following combinations of applicable standards:

      1) Class I, Division 1: UL 1203, UL 913, NFPA 496, UL 60079-28, and UL 60079-33.
      2) Class I, Division 2: UL 121201, NFPA 496, UL 60079-28, and UL 60079-33.
      3) Class II, Division 1: UL 1203, UL 913, NFPA 496, UL 60079-28, and UL 60079-33.
      4) Class II, Division 2: UL 121201, NFPA 496, UL 60079-28, and UL 60079-33.
      5) Class III, Divisions 1 and 2: UL 913, UL 121201, and UL 60079-33.

5. Standard Features:

    a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047.
    b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
    c. Motor Rating: Motor-circuit switches marked with horsepower ratings for starting characteristics of motor.
    d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
    e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
    f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
    g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
    h. Poles: [**Two**][**Three**][**Four**] .
    i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
    j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
    k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
    l. Fusing: [**Fused**][**Nonfused**] .
    m. Load Class: [**General**][**Isolating**] Use.
    n. Throw: [**Single**][**Double**] .

6. Accessories:

    a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
    b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
    c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
    d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
    e. Service-Rated Switches: Labeled for use as service equipment.
    f. Hookstick Handle: Allows use of hookstick to operate handle.
    g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
    h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

2.5 FUSED POWER-CIRCUIT DEVICES

A. UL IYSR - Enclosed Fused Bolted-Pressure Contact Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**Eaton**]
    b. [**Schneider Electric USA, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Eaton**]
b. [**Schneider Electric USA, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

a. Listed Fused Power-Circuit Devices: UL CCN IYSR, including UL 977.

5. Standard Features:

a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047 providing additional pressure or clamping action at both ends of the switch blades when the blades are in a fully closed position.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Motor Rating: Motor-circuit switches marked with horsepower ratings for starting characteristics of motor.
d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
h. Poles: [**Two**][**Three**][**Four**] .
i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
l. Fusing: [**Fused**][**Nonfused**] .
m. Load Class: [**General**][**Isolating**] Use.
n. Throw: [**Single**][**Double**] .

6. Accessories:

a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
e. Service-Rated Switches: Labeled for use as service equipment.
f. Hookstick Handle: Allows use of hookstick to operate handle.
g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

B. UL IYSR - Enclosed Fused High-Pressure Butt-Type Contact Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ABB**]
    b. [**Eaton**]
    c. [**Siemens**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB**]
    b. [**Eaton**]
    c. [**Siemens**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

    a. Listed Fused Power-Circuit Devices: UL CCN IYSR, including UL 977.

5. Standard Features:

    a. Product Reference Standard: "Heavy Duty" switches meeting requirements of NEMA BS 31047 and having butt-type contacts and a spring-charged mechanism.
    b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
    c. Motor Rating: Motor-circuit switches marked with horsepower ratings for starting characteristics of motor.
    d. Short-Circuit Current Rating: As determined by results of Power System Studies [**and selection of fuses**] .
    e. Fuseholders: Provide clips or bolt pads to accommodate selected fuses.
    f. Lockable Handle: Capability to accept three padlocks, and interlocked with cover in closed position.
    g. Voltage Rating: [**120 V(ac)**][**120/240 V(ac)**][**125 V(dc)**][**125/250 V(dc)**][**240 V(ac)**][**240/480 V(ac)**][**250 V(dc)**][**480 V(ac)**][**600 V(ac)**][**600 V(dc)**] .
    h. Poles: [**Two**][**Three**][**Four**] .
    i. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
    j. Current Rating: [**30 A**][**60 A**][**100 A**][**200 A**][**400 A**][**600 A**][**800 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**] .
    k. Horsepower Rating: [**1/2 hp**][**1-1/2 hp**][**2 hp**][**3 hp**][**5 hp**][**7-1/2 hp**][**10 hp**][**15 hp**][**25 hp**][**30 hp**][**50 hp**][**60 hp**][**75 hp**][**100 hp**][**200 hp**][**250 hp**] .
    l. Fusing: [**Fused**][**Nonfused**] .
    m. Load Class: [**General**][**Isolating**] Use.
    n. Throw: [**Single**][**Double**] .

6. Accessories:

a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
c. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
e. Service-Rated Switches: Labeled for use as service equipment.
f. Hookstick Handle: Allows use of hookstick to operate handle.
g. Auxiliary Contact Kit: [**One**][**Two**] N.O./N.C. (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**6 V(dc)**][**12 V(dc)**][**24 V(dc)**] .
h. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, and conductor material.

2.6 MOLDED-CASE CIRCUIT BREAKERS AND ENCLOSURES

A. UL DIVQ - Enclosed Molded-Case Circuit Breaker :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

    a. [**ABB**]
    b. [**ABB Industrial Connections and Solutions LLC (GE ED&C)**]
    c. [**Eaton**]
    d. [**Hubbell Inc Wiring Device Div**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Littelfuse, Inc.**]
    g. [**NOARK Electric North America**]
    h. [**Siemens Industry, Inc.**]
    i. [**Square D; Schneider Electric USA**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB**]
    b. [**ABB Industrial Connections and Solutions LLC (GE ED&C)**]
    c. [**Eaton**]
    d. [**Hubbell Inc Wiring Device Div**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Littelfuse, Inc.**]
    g. [**NOARK Electric North America**]
    h. [**Siemens Industry, Inc.**]
    i. [**Square D; Schneider Electric USA**]
    j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with the following guide information and corresponding standards:

a. Listed Fused Power-Circuit Devices: UL CCN DIVQ, including UL 489.

5. Standard Features:

a. Product Reference Standard: NEMA AB 3.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Short-Circuit Current Rating: As determined by results of Power System Studies.
d. System Frequency: [**50/60 Hz**][**DC**][**400 Hz**]<**Insert frequency**> .
e. Voltage Rating: [**120 V(ac)**][**125 V(ac)**][**120/240 V(ac)**][**208 V(ac)**][**208Y/120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**480Y/277 V(ac)**][**480 V(ac)**][**347 V(ac)**][**600Y/347 V(ac)**][**600 V(ac)**][**24 V(dc)**][**48 V(dc)**][**60 V(dc)**][**65 V(dc)**][**80 V(dc)**][**125 V(dc)**][**125/250 V(dc)**][**160 V(dc)**][**250 V(dc)**][**500 V(dc)**][**600 V(dc)**] .
f. Poles: [**One**][**Two**][**Three**][**(corner-grounded delta)**] .
g. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
h. Current Rating: [**15 A**][**20 A**][**25 A**][**30 A**][**34 A**][**40 A**][**45 A**][**50 A**][**60 A**][**70 A**][**80 A**][**90 A**][**100 A**][**110 A**][**125 A**][**150 A**][**175 A**][**200 A**][**225 A**][**250 A**][**300 A**][**350 A**][**400 A**][**450 A**][**500 A**][**600 A**][**700 A**][**800 A**][**1000 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**][**5000 A**][**6000 A**] .
i. Tripping Means: [**Thermal-Magnetic**][**Hydraulic-Magnetic**][**Electronic (Solid-State)**] .
j. Intended Use: [**Main**][**Feeder**][**Branch circuit**] protection.
k. Specific Purpose Categories:

1) Remotely operated.
2) Integrally-fused.
3) Current-limiting.
4) Switching Duty (SWD).
5) Instantaneous trip only (motor circuit protector or circuit interrupter).
6) Heating, air conditioning, and refrigeration (HACR).
7) Marine.
8) Naval.
9) Mining.
10) High intensity discharge lighting (HID).
11) Ground-fault circuit interrupter (GFCI).
12) Arc-fault circuit interrupter (AFCI).
13) Equipment ground-fault protective device.
14) Classified (alternates).
15) Secondary surge arrester.
16) Transient voltage surge suppressor (TVSS).
17) For use with uninterruptible power supplies (UPS).
18) 100 percent rated.
19) Photovoltaic (PV).

l. Fusing: [**Fused**][**Nonfused**] .
m. Conductor Connections: [**Front-connected**][**Rear-connected**] .
n. Mounting Arrangement: [**Stationary**][**Plug-in**][**Drawout**] .
o. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, trip ratings, and conductor material. Suitable for [**60 deg C rated wire on 125 A circuit breakers and below**][**75 deg C rated wire**][**90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70**] .
p. Ground-Fault Protection: Comply with UL 1053; [**integrally mounted, self-powered**][**remote-mounted and powered**] type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
q. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**Din-rail-mounted**] communication module with functions and features

compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring."

6. Accessories:

   a. Interchangeable Trip Unit: Field-installable assembly that controls tripping functions.
   b. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   c. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   d. Auxiliary Switch: [**Rated for pilot duty**][**Not rated for pilot duty**] . [**One SPDT switch**][**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
   e. Alarm Switch: [**Rated for pilot duty**][**Not rated for pilot duty**] . One [**N.O.**][**N.C.**] contact operates only when circuit breaker has tripped.
   f. Electrical Operator: Provide remote control for on, off, and reset operations.
   g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
   h. Zone-Selective Interlocking: Integral with [**electronic**][**ground-fault**] trip unit; for interlocking ground-fault protection function.
   i. Handle Locking Device: Capable of locking circuit breaker in isolated position.
   j. Accessory Control Power: [**Integrally mounted, self-powered**][**Remote mounted and powered**] ; [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**12 V(dc)**][**24 V(dc)**][**120 V(dc)**] .

2.7 MOLDED-CASE SWITCHES AND ENCLOSURES

A. UL WJAZ - Enclosed Molded-Case Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**] :

   a. [**ABB Industrial Connections & Solutions LLC**]
   b. [**Bussmann; Eaton, Electrical Sector**]
   c. [**Eaton**]
   d. [**NOARK Electric North America**]
   e. [**Schneider Electric USA, Inc.**]
   f. [**Siemens Industry, Inc.**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Industrial Connections & Solutions LLC**]
   b. [**Bussmann; Eaton, Electrical Sector**]
   c. [**Eaton**]
   d. [**NOARK Electric North America**]
   e. [**Schneider Electric USA, Inc.**]
   f. [**Siemens Industry, Inc.**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with the following guide information and corresponding standards:

a. Listed Fused Power-Circuit Devices: UL CCN WJAZ, including UL 489.

5. Standard Features:

a. Product Reference Standard: NEMA AB 3 and is designed to open and close a circuit by nonautomatic means.
b. Enclosure Rating: Marked for intended use and location in accordance with UL 50E.
c. Short-Circuit Current Rating: As determined by results of Power System Studies.
d. System Frequency: [**50/60 Hz**][**DC**][**400 Hz**]<**Insert frequency**> .
e. Voltage Rating: [**120 V(ac)**][**125 V(ac)**][**120/240 V(ac)**][**208 V(ac)**][**208Y/120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**480Y/277 V(ac)**][**480 V(ac)**][**347 V(ac)**][**600Y/347 V(ac)**][**600 V(ac)**][**24 V(dc)**][**48 V(dc)**][**60 V(dc)**][**65 V(dc)**][**80 V(dc)**][**125 V(dc)**][**125/250 V(dc)**][**160 V(dc)**][**250 V(dc)**][**500 V(dc)**][**600 V(dc)**] .
f. Poles: [**One**][**Two**][**Three**][**(corner-grounded delta)**] .
g. Wires: [**Two**][**Three**][**Four**][**Five**][**(including solid neutral)**] .
h. Current Rating: [**15 A**][**20 A**][**25 A**][**30 A**][**34 A**][**40 A**][**45 A**][**50 A**][**60 A**][**70 A**][**80 A**][**90 A**][**100 A**][**110 A**][**125 A**][**150 A**][**175 A**][**200 A**][**225 A**][**250 A**][**300 A**][**350 A**][**400 A**][**450 A**][**500 A**][**600 A**][**700 A**][**800 A**][**1000 A**][**1200 A**][**1600 A**][**2000 A**][**2500 A**][**3000 A**][**4000 A**][**5000 A**][**6000 A**] .
i. Tripping Means: [**Thermal-Magnetic**][**Hydraulic-Magnetic**][**Electronic (Solid-State)**] .
j. Intended Use: [**Main**][**Feeder**][**Branch circuit**] protection.
k. Specific Purpose Categories:

1) Remotely operated.
2) Integrally-fused.
3) Current-limiting.
4) Switching Duty (SWD).
5) Instantaneous trip only (motor circuit protector or circuit interrupter).
6) Heating, air conditioning, and refrigeration (HACR).
7) Marine.
8) Naval.
9) Mining.
10) High intensity discharge lighting (HID).
11) Ground fault circuit interrupter (GFCI).
12) Arc fault circuit interrupter (AFCI).
13) Equipment ground fault protection.
14) Classified (alternates).
15) Secondary surge arrester.
16) Transient voltage surge suppressor (TVSS).
17) For use with uninterruptible power supplies (UPS).
18) 100 percent rated.
19) Photovoltaic (PV).

l. Fusing: [**Fused**][**Nonfused**] .
m. Conductor Connections: [**Front-connected**][**Rear-connected**] .
n. Mounting Arrangement: [**Stationary**][**Plug-in**][**Drawout**] .
o. Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, trip ratings, and conductor material. Suitable for [**60 deg C rated wire on 125 A switches and below**][**75 deg C rated wire**][**90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70**] .
p. Ground-Fault Protection: Comply with UL 1053; [**integrally mounted, self-powered**][**remote-mounted and powered**] type with mechanical ground-fault indicator;

relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

q. Communication Capability: [**Circuit-breaker-mounted**][**Universal-mounted**][**Integral**][**DIN-rail-mounted**] communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring."

6. Accessories:

a. Interchangeable Trip Unit: Field-installable assembly that controls tripping functions.
b. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
c. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
d. Auxiliary Switch: [**Rated for pilot duty**][**Not rated for pilot duty**] . [**One SPDT switch**][**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
e. Alarm Switch: [**Rated for pilot duty**][**Not rated for pilot duty**] . One [**N.O.**][**N.C.**] contact operates only when switch has tripped.
f. Electrical Operator: Provide remote control for on, off, and reset operations.
g. Key Interlock Kit: Externally mounted to prohibit switch operation; key must be removable only when switch is in off position.
h. Zone-Selective Interlocking: Integral with [**electronic**][**ground-fault**] trip unit; for interlocking ground-fault protection function.
i. Handle Locking Device: Capable of locking switch in isolated position.
j. Accessory Control Power: [**Integrally mounted, self-powered**][**Remote mounted and powered**] ; [**24 V(ac)**][**120 V(ac)**][**208 V(ac)**][**240 V(ac)**][**12 V(dc)**][**24 V(dc)**][**120 V(dc)**] .

2.8 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. [**Include the following:**]

1. Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Fuse Pullers: [**Two**]<**Insert number**> for each size and type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, [**Type 1**]<**Insert type**> .

B. Outdoor Locations: UL 50E, [**Type 3R**][**Type 4X**]<**Insert type**> .

C. Kitchen and Wash-Down Areas: UL 50E, [**Type 4X**]<**Insert type**> , [**stainless steel**]<**Insert material**> .

D. Other Wet or Damp, Indoor Locations: UL 50E, [**Type 4**]<**Insert type**> .

E. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

F. Hazardous Areas Indicated on the Drawings: UL 50E, [**Type 7**][**Type 9**]<**Insert type**>[**with cover attached by Type 316 stainless steel bolts**] .

3.3 INSTALLATION, GENERAL

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
6. Hot Work: NFPA 51B.
7. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, NFPA 1225, and NECA NEIS 305.
8. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
9. Communications Work: BICSI N1.
10. Work in ITE Rooms: NFPA 75.
11. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
12. Life Safety and Means of Egress Work: NFPA 101.
13. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
14. Work in Confined Spaces: NFPA 350.
15. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
16. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
17. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:

1. Identification: Provide labels for enclosed switches, circuit breakers, and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

2. Grounding and Bonding:

    a. Equipment Grounding Conductors: Provide and route insulated equipment grounding conductors with other feeder or branch circuit conductors. Bond equipment grounding conductor to enclosure using provided hardware in accordance with manufacturer's published instructions.
    b. Equipment Bonding Conductors: Provide equipment bonding straps or jumpers where additional bonding is indicated on the Drawings between enclosed switches or circuit breakers and adjacent metallic equipment, enclosures, piping, or building structure. Route

bonding conductors along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access panels or placing conductors where they may be subjected to strain, impact, or damage.

3.4 INSTALLATION OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Special Techniques:

1. Layout Coordination: Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Mounting Heights: Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Seismic Controls: Provide equipment mounts and anchors complying with seismic requirements for the Project.
4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Fusing: Install fuses in fusible devices.

3.5 FIELD QUALITY CONTROL OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**] .

B. Acceptance Testing Preparation: <**Insert requirements**> .

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**> .

D. Tests and Inspections for Enclosed Switches, Dead-Front Switches, Enclosed Switches for Use in Hazardous (Classified) Locations, and Fused Power-Circuit Devices:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and the Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the methods as follows:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar

connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

E. Tests and Inspections for Molded-Case Circuit Breakers and Enclosures and for Molded-Case Switches and Enclosures:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that unit is clean.
e. Operate circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the methods as follows:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 MΩ.
e. Determine the primary current injection by the following:

1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.

f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.
h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Test and adjust controls, remote monitoring, and safeties.

F. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate in accordance with manufacturer's published instructions.

B. Set field-adjustable circuit-breaker trip ranges [**in accordance with results of power system studies.**][**to values indicated on the Drawings.**][**to values indicated in attached schedule.**]

3.7 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Infrared Scanning of Enclosed Switches and Circuit Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Field Reports for Infrared Scanning: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 28 16 00

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Task	Specification	Specification Description
26 28 16 13	26 24 16 00	Panelboards
26 28 16 13	26 28 16 00	Enclosed Switches And Circuit Breakers
26 28 16 16	26 28 16 00	Enclosed Switches And Circuit Breakers

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SECTION 26 29 13 00 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Magnetic motor controllers.
3. Combination motor controllers.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-[**and wind-**]control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SCPD: Short-circuit protective device.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. Laboratory and file number for listing by qualified electrical testing laboratory.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

    a. Listing document proving Type 2 coordination.

7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Field quality-control reports.

E. System startup testing reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for infrared scanning.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; [**install temporary electric heating, with at least**][**50 W**]<**Insert number**>[**per controller**][**connect factory-installed space heaters to temporary electrical service**].

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than **23 deg F (minus 5 deg C)** and not exceeding **104 deg F (40 deg C)**.
2. Altitude: Not exceeding **6600 ft (2010 m)** for electromagnetic and manual devices.
3. The effect of solar radiation is insignificant.

4. <**Insert unusual service condition**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Enclosures:

1. Environmental Ratings: Comply with UL 50E, type designations as indicated on the Drawings.
2. Construction: Comply with NEMA IA 10030.
3. Controllers in Hazardous (Classified) Locations: Comply with UL 1203.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB, Motion Business**]
b. [**Eaton**]
c. [**Rockwell Automation, Inc.**]
d. [**Siemens Industry, Inc., Energy Management Division**]
e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB, Motion Business**]
b. [**Eaton**]
c. [**Rockwell Automation, Inc.**]
d. [**Siemens Industry, Inc., Energy Management Division**]

e. [**Square D; Schneider Electric USA**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

   a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
   b. Configuration: [**Nonreversing**][**Reversing**][**Two speed**].
   c. Mounting: [**Flush**][**Surface**].
   d. Pilot Light Color: [**Red**][**Green**].
   e. Additional Nameplates: [**FORWARD and REVERSE for reversing switches**][**HIGH and LOW for two-speed switches**]<**Insert special markings**>.

B. Fractional Horsepower Manual Controllers (FHPMC) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

    a. Referenced Standards: Comply with NEMA ICS 2.

        1) Overload Relays:

            a) Inverse-time-current characteristics; [**Class 10**]<**Insert class**> tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button[**; bimetallic type**][**; melting alloy type**].
            b) Bimetallic class as scheduled on the Drawings.

    b. Configuration: [**Nonreversing**][**Two speed**].
    c. Pilot Light: [**Red**]<**Insert color**>.

C. Integral Horsepower Manual Controllers (IHPMC) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ABB Electrification Installations Products**]
    b. [**ABB, Motion Business**]
    c. [**Eaton**]
    d. [**Rockwell Automation, Inc.**]
    e. [**Siemens Industry, Inc., Energy Management Division**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ABB Electrification Installations Products**]
    b. [**ABB, Motion Business**]
    c. [**Eaton**]
    d. [**Rockwell Automation, Inc.**]
    e. [**Siemens Industry, Inc., Energy Management Division**]
    f. [**Square D; Schneider Electric USA**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

    a. Referenced Standards: Comply with NEMA ICS 2.

1) Overload Relays:

a) Inverse-time-current characteristics; [**Class 10**]<**Insert class**> tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button[**; bimetallic type**][**; melting alloy type**].
b) Bimetallic class as scheduled on the Drawings.

b. Configuration: [**Nonreversing**][**Two speed**].

2.3 MAGNETIC MOTOR CONTROLLERS

A. Enclosed Full-Voltage Magnetic Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Motor Controllers, Magnetic: UL CCN NLDX, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Across-the-line start, electrically held, for nominal system voltage of 600 V(ac) and less.

a. Referenced Standards: Comply with UL 508 and NEMA ICS 2, general purpose, Class A.
b. Configuration: [**Nonreversing**]<**Insert configuration**>.
c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.

1) Spare CPT Capacity as Indicated on the Drawings: [**50**][**100**][**200**]<**Insert number**> VA.

e. Overload Relays:

1) Thermal Overload Relays:

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters: In each phase; coordinate with nameplate full-load current of actual protected motor; include appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

g. Digital communication module, using [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

B. Enclosed Reduced-Voltage Magnetic Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]

f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Motor Controllers, Magnetic: UL CCN NLDX, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Electrically held; closed transition; adjustable time delay on transition, 600 V(ac) or less.

a. Referenced Standards: Comply with UL 508 and NEMA ICS 2, general purpose, Class A.
b. Configuration:

1) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
2) Part-Winding Controller: Separate START and RUN contactors, field-selectable for one-half- or two-thirds-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
3) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.

c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: [**24**][**120**] V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

1) Spare CPT Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

e. Overload Relays:

1) Thermal Overload Relays: [**Melting alloy type**][**Bimetallic type**].

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters in each phase matched to nameplate full-load current of actual

protected motor and with appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
g. Digital Communication Module: [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

C. Multispeed Magnetic Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. Motor Controllers, Magnetic: UL CCN NLDX, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Two speed, full voltage, across the line, electrically held.

    a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
    b. Configuration: Nonreversing[**, multispeed**].

        1) Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

            a) Operating Voltage: Manufacturer's standard unless otherwise indicated.

        2) Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

            a) Control Power: [**24**][**120**] V(ac); obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
            b) Spare CPT Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

        3) Compelling Relays: Ensure that motor will start only at low speed.
        4) Accelerating Timer Relays: Ensure properly timed acceleration through speeds lower than that selected.
        5) Decelerating Timer Relays: Ensure automatically timed deceleration through each speed.
        6) Antiplugging Timer Relays: Ensure a time delay when transferring from FORWARD to REVERSE and back.

    c. Overload Relays:

        1) Thermal Overload Relays: [**Melting alloy type**][**Bimetallic type**].

            a) Inverse-time-current characteristic.
            b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
            c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
            d) Ambient compensated.
            e) Automatic resetting.

        2) Solid-State Overload Relay:

            a) Switch or dial selectable for motor-running overload protection.
            b) Sensors in each phase.
            c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

    d. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
    e. Digital communication module, using [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire**

connection to host devices with a compatible port]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

2.4 COMBINATION MAGNETIC MOTOR CONTROLLERS

A. Combination Full-Voltage Magnetic Motor Controller :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Combination Motor Controllers: UL CCN NKJH (36 BPMs), including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

   a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
   b. Configuration: [**Nonreversing**]<**Insert configuration**>.

c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.

1) Spare CPT Capacity as Indicated on the Drawings: [**50**][**100**][**200**]<**Insert number**> VA.

e. Overload Relays:

1) Thermal Overload Relays:

a) Inverse-time-current characteristic.
b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
c) Heaters: In each phase coordinate with nameplate full-load current of actual protected motor; include appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

g. Digital communication module, using [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

h. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.

2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

j. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

k. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

B. Combination Reduced-Voltage Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Combination Motor Controllers: UL CCN NKJH (36 BPMs), including UL 60947-1 and UL

60947-4-1.

5. Standard Features: Factory-assembled, combination reduced-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, and SCPD and OCPD, in a single enclosure.

   a. Configuration:

      1) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
      2) Part-Winding Controller: Separate START and RUN contactors, field-selectable for one-half- or two-thirds-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
      3) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.

   b. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

      1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

   c. Control Power: [**24**][**120**] V(ac); obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

      1) Spare CPT Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

   d. Overload Relays:

      1) Thermal Overload Relays: [**Melting alloy type**][**Bimetallic type**].

         a) Inverse-time-current characteristic.
         b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
         c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
         d) Ambient compensated.
         e) Automatic resetting.

      2) Solid-State Overload Relay:

         a) Switch or dial selectable for motor-running overload protection.
         b) Sensors in each phase.
         c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

   e. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
   f. Digital Communication Module: [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

      1) Instantaneous rms current each phase, and 3-phase average.

2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

g. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

h. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

j. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

C. Combination Multispeed Magnetic Motor Controller :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Combination Motor Controllers: UL CCN NKJH (36 BPMs), including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination of multispeed magnetic motor controller, consisting of the controller, indicated disconnecting means, and SCPD and OCPD, in a single enclosure.

   a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
   b. Configuration: [**Nonreversing**][**Reversing**]; [**consequent pole**][**two-winding**].

      1) Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

         a) Operating Voltage: Manufacturer's standard unless otherwise indicated.

      2) Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
      3) Control Power: [**24**][**120**] V(ac); obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

         a) Spare CPT Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

      4) Compelling Relays: Ensure that motor will start only at low speed.
      5) Accelerating Timer Relays: Ensure properly timed acceleration through speeds lower than that selected.
      6) Decelerating Timer Relays: Ensure automatically timed deceleration through each speed.
      7) Antiplugging Timer Relays: Ensure a time delay when transferring from FORWARD to REVERSE and back.

   c. Overload Relays:

      1) Thermal Overload Relays: [**Melting alloy type**][**Bimetallic type**].

         a) Inverse-time-current characteristic.
         b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
         c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
         d) Ambient compensated.
         e) Automatic resetting.

      2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

d. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

e. Digital communication module, using [**TIA-485 Modbus, RTU protocol,**][**2**][**4**][**-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous rms current each phase, and 3-phase average.
2) Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3) Active Energy (kWh): 3-phase total.
4) Power Factor:[**Each phase and**] 3-phase total.
5) <**Insert value**>.

f. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

g. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

h. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push-Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy duty or oiltight where indicated in the controller schedule.

a. Push-Buttons: As indicated in the controller schedule.
b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours[**; nonresettable**][**; resettable**].
3. Meters: Panel type, **2-1/2-inch (64-mm)** minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

B. Motor Protection Relays: Provide solid-state sensing circuit and isolated output contacts for hardwired connections.

1. Phase-failure.
2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.
4. <**Insert description**>.

C. Breather Assemblies: Maintain interior pressure and release condensation in [**Type 4**][**Type 4X**][**Type 7**][**Type 9**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Space Heaters: Provide N.C. auxiliary contacts, to mitigate condensation in [**Type 3R**][**Type 4X**][**Type 12**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Sun Shields: Install on fronts, sides, and tops of enclosures that are installed outdoors and subject to direct and extended sun exposure.

F. <**Insert accessories**>.

2.6 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing motor controllers, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Fuses for Fused Switches: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Control Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**two**]<**Insert number**> of each size and type.
3. Indicating Lights: [**Two**]<**Insert number**> of each type and color installed.
4. Auxiliary Contacts: Furnish [**one**]<**Insert number**> spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish [**three**]<**Insert number**> spares for each size and type of magnetic contactor installed.
6. <**Insert extra materials**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION OF MANUAL AND MAGNETIC MOTOR CONTROLLERS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NECA NEIS 1, NFPA 1, and NFPA 70.
2. Electrical Maintenance: NECA NEIS 91 and NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Work in Confined Spaces: NFPA 350.
8. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
9. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks for support unless otherwise indicated.
2. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s).
3. Provide seismic control devices.
4. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

D. Interfaces with Other Work:

1. Identification: Provide labels for motor controllers and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure and each compartment with [**baked-enamel signs**][**metal-backed butyrate signs**][**laminated acrylic or melamine plastic signs**], mounted with corrosion-resistant screws.
c. Provide warning signs for electrical equipment.

2. Arc-Flash Warning Labels:

a. Provide self-adhesive equipment label for each work location[**included in the arc-flash**

hazard analysis].

b. Labels must be machine printed, with no field-applied markings.
c. Labels must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from the arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

3.3 FIELD QUALITY CONTROL OF MANUAL AND MAGNETIC MOTOR CONTROLLERS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Comply with NFPA 70B.
2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Inspect contactors:

1) Verify mechanical operation.
2) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

f. Motor-Running Protection:

1) Verify overload element rating is correct for its application.
2) If motor-running protection is provided by fuses, verify correct fuse rating.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

a. [**For the contactor and circuit breaker, perform**][**Perform**] insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole.

1) Insulation Resistance: In accordance with manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5.
2) Investigate and correct insulation resistance values less than those of this table or manufacturer's published instructions.

b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
c. Test motor protection devices in accordance with manufacturer's published data.
d. Test circuit breakers as follows:

1) Operate the circuit breaker to ensure smooth operation.
2) For adjustable circuit breakers, adjust protective device settings in accordance with the coordination study. Comply with coordination study recommendations.

e. Perform operational tests by initiating control devices.

E. Nonconforming Work:

1. Motor controller will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service in accordance with manufacturer's published instructions.

B. System Startup Testing: Verify the correct interaction of sensing, processing, and action devices. Perform system startup testing after field quality control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

C. Nonconforming Work:

1. Motor controller will be considered defective if it does not pass system startup testing.

D. System Startup Testing Report: Compile, prepare, and submit system startup testing reports.

E. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain equipment specified in Section 262913.03 "Manual and Magnetic Motor Controllers."

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.6 MAINTENANCE

A. Infrared Scanning of Motor Controllers: Perform infrared scanning during periods of maximum possible loading. Comply with NFPA 70B requirements. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment must detect emitted radiation and convert detected radiation to a visual signal.
2. Act on inspection results and recommended action, and considering the recommendations of NETA ATS Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
3. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
4. Follow-On Infrared Scanning: Perform follow-up infrared scans of motor controller at 11 months after Substantial Completion.
5. Field Reports for Infrared Scanning: Prepare a certified report including the following information:

a. Identities of personnel performing infrared scanning.

b. Description of test equipment used and record of their calibration.
c. Description of motor controllers and associated equipment tested.
d. Deficiencies found, remedial actions taken, and observations found when scans were repeated after the remedial actions.
e. Temperature difference between the area of concern and the reference area.
f. Probable cause of temperature difference.
g. Areas inspected. Identify inaccessible and unobservable areas and equipment.
h. Load conditions at time of inspection.
i. Photographs and thermograms of the deficient area.
j. Recommended action.

END OF SECTION 26 29 13 00

SECTION 26 29 13 00A - SOFT-START MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soft-start motor controllers.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-[**and wind-**]control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
9. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies field-installed surge protection referenced by this Section.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. FLA: Full-load amperes.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor circuit protector.

E. N.C.: Normally closed.

F. N.O.: Normally open.

G. OCPD: Overcurrent protective device.

H. SCCR: Short-circuit current rating.

I. SCPD: Short-circuit protective device.

J. SCR: Silicon-controlled rectifier.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.

C. Product Schedule: For each enclosed controller.

1. Each installed soft-start controller type.
2. Laboratory and file number for listing by qualified electrical testing laboratory..
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.

a. For each combination soft-start controller, include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

1) Listing document proving Type 2 coordination.

b. For each series-rated combination, state the listed integrated SCCR (withstand) of SCPDs and OCPDs by qualified electrical testing laboratory acceptable to authorities having jurisdiction.

D. Field quality-control reports.

E. System startup testing reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

2. Manufacturer's field reports for system startup support.
3. Field reports for infrared scanning.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store soft-start controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect soft-start controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover soft-start controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; [**install temporary electric heating, with at least**][**50 W**]<**Insert number**>[**per controller**][**connect factory-installed space heaters to temporary electrical service**].

1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than **32 deg F (0 deg C)** and not exceeding **104 deg F (40 deg C)**, humidity noncondensing.
2. Altitude: Not exceeding **3300 ft (1000 m)**.
3. The effect of solar radiation is insignificant.
4. <**Insert unusual service condition**>.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Enclosures:

1. Environmental Ratings: Comply with UL 50E, type designations as indicated on Drawings.
2. Construction: Comply with NEMA ICS IA 10030.
3. Controllers in Hazardous (Classified) Locations: Comply with UL 1203.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 SOFT-START MOTOR CONTROLLERS

A. Enclosed Soft-Start Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Mechanically Operated and Solid-State: UL CCN NMFT, including UL 508, UL 60947-1, and UL 60947-4-1.

5. Standard Features: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop.

   a. Construction: Integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
   b. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
   c. Referenced Standards: NEMA ICS 2, general purpose, Class A.
   d. Configuration: [**Standard duty**]<**Insert configurations**>.

      1) Motor Starting and Stopping: Provide at least two SCRs per phase.
      2) Microprocessor Control: Continuously monitor current and proper operation of the SCRs.

   e. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls must remain active when this contactor is in the bypass mode.

      1) Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and opens automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
      2) Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
      3) Surge Protection: Provide [**NEMA ICS 2 compliant factory-installed**][**field-installed**] surge suppression.

   f. Control Power:

      1) For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      2) Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

   g. Controller Diagnostics and Protection:

      1) Microprocessor-based thermal-protection system for monitoring SCR and motor

thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.

2) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
3) Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
4) <**Insert items**>.

h. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

1) Starter Status: "Ready," "Starting," "Stopping," or "Run."
2) Motor current in amperes.
3) Faults:

a) Motor overcurrent trip.
b) Motor thermal overload.
c) Starter thermal fault.
d) Low line voltage.
e) Loss of a phase.
f) Phases reversed.
g) Maximum stating time exceeded.
h) Serial communications error.

i. Interface Panel: [**Mounted on controller door**][**Mounted remotely within 50 ft (15 m)**].[**With plug-in connector and removable.**]

1) Guarded adjustable set points, not readily accessible.

a) Motor FLA, adjustable from [**40 to 110**]<**Insert numbers**> percent of the controller's rating.
b) Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
c) NEMA ICS 2 Overload Class: Include the following selections: Class 5, Class 10, Class 15, Class 20, and Class 30.

2) Adjustable set points, readily accessible[**, password protected**].

a) Linear acceleration, adjustable from [**1 to 60 s**]<**Insert range in seconds**>.
b) Maximum start time, adjustable from [**1 to 250 s**]<**Insert range in seconds**>.
c) Selector switch; select coast to stop or soft stop.
d) Linear deceleration, adjustable from [**1 to 60 s**]<**Insert range in seconds**>.

j. Remote Output Features. All outputs prewired to terminal blocks.

1) Analog output for field-selectable assignment of motor operating characteristics; [**0- to 10 V(dc)**][**4- to 20 mA(dc)**].
2) Form C status contacts that change state when controller is running.
3) Form C alarm contacts that change state when a fault condition occurs.
4) <**Insert items**>.

k. Digital Communication Module: [**TIA-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port**][**TIA-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous root mean square (RMS) current each phase, and three-phase average.
2) RMS Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
3) Active Energy (kilowatt-hour): Three-phase total.
4) Power Factor:[**Each phase and**] three-phase total.
5) <**Insert value**>.

B. Combination Soft-Start Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ABB Electrification Installations Products**]
   b. [**ABB, Motion Business**]
   c. [**Eaton**]
   d. [**Rockwell Automation, Inc.**]
   e. [**Siemens Industry, Inc., Energy Management Division**]
   f. [**Square D; Schneider Electric USA**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. Motor Controllers, Mechanically Operated and Solid-State: UL CCN NMFT, including UL 508, UL 60947-1, and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination, reduced-voltage soft-start controller with a disconnecting means, SCPD and OCPD, in a single enclosure.

   a. Construction: Integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
   b. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
   c. Referenced Standards: NEMA ICS 2, general purpose, Class A.
   d. Configuration: [**Standard duty**]<**Insert configurations**>.

1) At least two SCRs per phase to control the starting and stopping of the motor.
2) Continuously monitor current and proper operation of the SCRs.
3) Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls remain active when this contactor is in the bypass mode.
4) Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and opens automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
5) Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
6) Surge Protection: Provide [**NEMA ICS 2 compliant factory-installed**][**field-installed**] surge suppression.

e. Control Power:

1) For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.
2) Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

f. Controller Diagnostics and Protection:

1) Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
2) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
3) Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
4) <**Insert items**>.

g. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

1) Starter Status: "Ready," "Starting," "Stopping," or "Run."
2) Motor current in amperes.
3) Faults:

a) Motor overcurrent trip.
b) Motor thermal overload.
c) Starter thermal fault.
d) Low line voltage.
e) Loss of a phase.
f) Phases reversed.
g) Maximum stating time exceeded.
h) Serial communications error.

h. Interface Panel: [**Mounted on controller door**][**Mounted remotely within 50 ft (15 m)**].[**With plug-in connector and removable.**]

1) Guarded adjustable set points, not readily accessible.

a) Motor FLA, adjustable from [**40 to 110**]<**Insert numbers**> percent of the controller's rating.

b) Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
c) NEMA ICS 2 Overload Class: Include the following selections: Class 5, Class 10, Class 15, Class 20, and Class 30.

2) Adjustable set points, readily accessible[**, password protected**].

a) Linear acceleration, adjustable from [**1 to 60 s**]<**Insert range in seconds**>.
b) Maximum start time, adjustable from [**1 to 250 s**]<**Insert range in seconds**>.
c) Selector switch; select coast to stop or soft stop.
d) Linear deceleration, adjustable from [**1 to 60 s**]<**Insert range in seconds**>.

i. Remote Output Features: All outputs prewired to terminal blocks.

1) Analog output for field-selectable assignment of motor operating characteristics; [**0- to 10 V(dc)**][**4- to 20 mA(dc)**].
2) Form C status contacts that change state when controller is running.
3) Form C alarm contacts that change state when a fault condition occurs.
4) <**Insert items**>.

j. Digital Communication Module: [**TIA-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port**][**TIA-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

1) Instantaneous RMS current each phase, and three-phase average.
2) RMS Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
3) Active Energy (kilowatt-hour): Three-phase total.
4) Power Factor:[**Each phase and**] three-phase total.
5) <**Insert value**>.

k. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate [**Class J**][**Class L**][**indicated**] fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary Contacts: N.O. or N.C., arranged to activate before switch blades open.

l. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
4) [**N.C.**][**N.O.**] alarm contact that operates only when MCP has tripped.
5) Current-limiting module to increase controller SCCR (withstand) to 100 kA.

m. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
5) [**N.C.**][**N.O.**] alarm contact that operates only when MCCB has tripped.

n. Molded-Case Switch Disconnecting Means:

1) UL 489 and NEMA AB 3, with in-line fuse block for Class J or Class L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3) Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
4) [**N.C.**][**N.O.**] alarm contact that operates only when molded-case switch has tripped.

C. Bypass Motor Controller :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ABB Electrification Installations Products**]
b. [**ABB, Motion Business**]
c. [**Eaton**]
d. [**Rockwell Automation, Inc.**]
e. [**Siemens Industry, Inc., Energy Management Division**]
f. [**Square D; Schneider Electric USA**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. Motor Controllers, Mechanically Operated and Solid-State: UL CCN NMFT, including UL 508, UL 60947-1, and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination, full-voltage electromagnetic motor controller with a disconnecting means, SCPD and OCPD, in a single enclosure. Connected as a

bypass controller, operating manually, with NORMAL/BYPASS selector switch.

a. Referenced Standards: NEMA ICS 2, general purpose, Class A.
b. Configuration: Across-the-line start, electrically held.
c. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

    1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: [**24**][**120**] V(ac); obtained from integral CPT, with primary and secondary fuses, and with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

    1) Spare CPT Capacity: As indicated on Drawings, [**50**][**100**][**200**]<**Insert number**> VA.

e. Overload Relays:

    1) Thermal-Overload Relays:

        a) Inverse-time-current characteristic.
        b) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
        c) Heaters: In each phase; coordinate with nameplate FLA of actual protected motor; include appropriate adjustment for duty cycle.
        d) Ambient compensated.
        e) Automatic resetting.

    2) Solid-State Overload Relays:

        a) Switch or dial selectable for motor running overload protection.
        b) Sensors in each phase.
        c) [**Class 10**][**Class 20**][**Class 30**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
g. Digital Communication Module: [**TIA-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port**][**TIA-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port**]<**Insert protocol**> to transmit the following to the LAN:

    1) Instantaneous RMS current each phase, and three-phase average.
    2) RMS Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
    3) Active Energy (kilowatt-hour): Three-phase total.
    4) Power Factor:[**Each phase and**] three-phase total.
    5) <**Insert value**>.

h. Fusible Disconnecting Means:

    1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
    2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

j. MCP Disconnecting Means:

1) UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

k. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push-Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy duty or oiltight where indicated in the controller schedule.

a. Push-Buttons: As indicated in the controller schedule.
b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours[**; nonresettable**][**; resettable**].
3. Meters: Panel type, **2-1/2 inch (64 mm)** minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide selector switches with an off position.

B. Breather Assemblies: Maintain interior pressure and release condensation in [**Type 4**][**Type 4X**][**Type 7**][**Type 9**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

C. Space Heaters: Provide N.C. auxiliary contacts, to mitigate condensation in [**Type 3R**][**Type 4X**][**Type 12**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Sun Shields: Install on fronts, sides, and tops of enclosures that are installed outdoors and subject to direct and extended sun exposure.

E. <**Insert accessories**>.

2.4 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing motor controllers, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Fuses for Fused Switches: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Control Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**two**]<**Insert number**> of each size and type.
3. Indicating Lights: [**Two**]<**Insert number**> of each type and color installed.
4. Auxiliary Contacts: Furnish [**one**]<**Insert number**> spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish [**three**]<**Insert number**> spares for each size and type of magnetic contactor installed.
6. <**Insert extra materials**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION OF SOFT-START MOTOR CONTROLLERS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B and NECA NEIS 91.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Work in Confined Spaces: NFPA 350.
8. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
9. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems and bolted to wall.
2. Freestanding Controllers: Provide slotted support systems.
3. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s).
4. Provide seismic control devices.
5. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.
6. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and

distribution spools.

7. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and similar motors.

D. Interfaces with Other Work:

1. Identification: Provide labels for motor controllers and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure and each compartment with [**baked enamel signs**][**metal backed butyrate signs**][**laminated acrylic or melamine plastic signs**], mounted with corrosion-resistant screws
c. Provide warning signs for electrical equipment.

2. Arc-Flash Warning Labels:

a. Provide self-adhesive equipment label for each work location [**included in the arc-flash hazard analysis**].
b. Labels must be machine printed, with no field-applied markings.
c. Labels must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from the arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

3.3 FIELD QUALITY CONTROL OF SOFT-START MOTOR CONTROLLERS

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Tests and Inspections:

1. Comply with NFPA 70B.
2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and the Specifications.

b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify that the unit is clean.
e. Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.
f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
g. Inspect Contactors:

1) Verify mechanical operation.
2) Verify that contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

h. Motor-Running Protection:

1) Verify that motor FLA is at, or under, the controller current rating.
2) Verify that overload element setting is correct for its application.
3) Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.
4) If motor-running protection is provided by fuses, verify correct fuse rating.

i. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12.

j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

a. [**For the contactor and circuit breaker, perform**][**Perform**] insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole.

1) Insulation Resistance: In accordance with manufacturer's published instructions or NETA ATS, Table 100.1. In the absence of manufacturer's published instructions, use Table 100.5.
2) Investigate and correct insulation resistance values less than those of this table or manufacturer's published instructions.

b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
c. Test motor protection devices according to manufacturer's published instructions.
d. Test circuit breakers as follows:

1) Operate the circuit breaker to ensure smooth operation.
2) For adjustable circuit breakers, adjust protective device settings in accordance with the coordination study. Comply with coordination study recommendations.

e. Test the electronic motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

f. Test the following parameters in accordance with NETA relay calibration procedures, or as recommended by manufacturer:

1) ANSI No. 49R, Overtemperature Protection:

a) Determine time delay at 300 percent of setting.
b) Determine a second point on the operating curve.
c) Determine pickup.

2) ANSI No. 47, Input Phase Loss and Reversed Phases Protection:

a) Determine positive sequence voltage to close the N.O. contact.
b) Determine positive sequence voltage to open the N.C. contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close the N.O. contact with sudden application of 120 percent of pickup.
e) Determine time delay to close the N.C. contact on removal of voltage when previously set to rated system voltage.

3) ANSI No. 81, Overfrequency Protection:

a) Verify frequency set points.
b) Determine time delay.
c) Determine undervoltage cutoff.

4) Fault Alarm Outputs: Verify that each relay contact performs its intended function in the control scheme including breaker trip tests, close inhibit tests, lockout tests, and alarm functions.

g. Perform operational tests by initiating control devices.

D. Nonconforming Work:

1. Motor controllers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service in accordance with manufacturer's published instructions.

B. System Startup Testing: Verify the correct interaction of sensing, processing, and action devices. Perform system startup testing after field quality-control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

C. Motor controllers will be considered defective if they do not pass system startup testing.

D. System Startup Testing Report: Compile, prepare, and submit test and inspection reports.

E. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain equipment specified in Section 262913.03 "Manual and Magnetic Motor Controllers."

2. [**Provide video recordings of training sessions to Owner**][**Allow Owner to record training sessions**].

3.6 MAINTENANCE

A. Infrared Scanning of Motor Controllers: Perform infrared scanning during periods of maximum possible loading. Comply with NFPA 70B requirements. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment detects emitted radiation and convert detected radiation to a visual signal.
2. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
3. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
4. Follow-On Infrared Scanning: Perform follow-up infrared scans of motor controller at 11 months after Substantial Completion.
5. Field Reports for Infrared Scanning: Prepare a certified report including the following information:

a. Identities of personnel performing infrared scanning.
b. Description of test equipment used and record of their calibration.
c. Description of motor controllers and associated equipment tested.

d. Deficiencies found, remedial actions taken, and observations found when scans were repeated after the remedial actions.
e. Temperature difference between the area of concern and the reference area.
f. Probable cause of temperature difference.
g. Areas inspected. Identify inaccessible and unobservable areas and equipment.
h. Load conditions at time of inspection.
i. Photographs and thermograms of the deficient area.
j. Recommended action.

END OF SECTION 26 29 13 00A

Task	Specification	Specification Description
26 29 13 13	26 29 13 00	Manual and Magnetic Motor Controllers
26 29 13 13	26 29 13 00a	Soft-Start Motor Controllers

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SECTION 26 29 23 00 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:

1. Section 262419 "Motor-Control Centers" for VFCs installed in motor-control centers.

1.2 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field

connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances and required area above and around VFCs.
2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
3. Show support locations, type of support, and weight on each support.
4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.

1. Certificate of compliance.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

D. Product Certificates: For each VFC from manufacturer.

E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
b. Manufacturer's written instructions for setting field-adjustable overload relays.
c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed,

and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**]<**Insert number**> of each size and type.
2. Control Power Fuses: Equal to [**10**]<**Insert number**> percent of quantity installed for each size and type, but no fewer than [**two**]<**Insert number**> of each size and type.
3. Indicating Lights: [**Two**]<**Insert number**> of each type and color installed.
4. Auxiliary Contacts: Furnish [**one**]<**Insert number**> spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish [**three**]<**Insert number**> spares for each size and type of magnetic contactor installed.
6. <**Insert extra materials**>.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and [**install temporary electric heating, with at least 250 W per controller**][**connect factory-installed space heaters to temporary electrical service**].

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide**

products by one of the following][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**ABB, Motion Business**]
3. [**Cerus Industrial, Inc.**]
4. [**Danfoss, Inc.**]
5. [**Eaton**]
6. [**Nidec Motor Corporation; Nidec Corporation**]
7. [**Rockwell Automation, Inc.**]
8. [**Schneider Electric USA, Inc.**]
9. [**Siemens Industry, Inc., Building Technologies Division**]
10. [**Yaskawa Electric America, Inc.**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**ABB, Motion Business**]
3. [**Cerus Industrial, Inc.**]
4. [**Danfoss, Inc.**]
5. [**Eaton**]
6. [**Nidec Motor Corporation; Nidec Corporation**]
7. [**Rockwell Automation, Inc.**]
8. [**Schneider Electric USA, Inc.**]
9. [**Siemens Industry, Inc., Building Technologies Division**]
10. [**Yaskawa Electric America, Inc.**]
11. <**Insert manufacturer's name**>

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and [**UL 508A**][**UL 508C**]<**Insert standard**>.

B. Application: [**Constant torque**][**and**][**variable torque**]<**Insert application**>.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**][**66 Hz, with torque constant as speed changes**]; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus [**10**][**15**] percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding [**3**][**5**] percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: [**96**][**97**]<**Insert number**> percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: [**96**][**98**]<**Insert number**> percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: [**10**][**22**][**65**][**100**]<**Insert value**> kA.
7. Ambient Temperature Rating: Not less than **32 deg F (0 deg C)** and not exceeding **104 deg F (40 deg C)**.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding **3300 feet (1000 m)**.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: [**1.1**][**1.5**] times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus [**5**][**10**] percent.
14. Output Carrier Frequency: Selectable; 0.5 to [**15**]<**insert number**> kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, [**16**][**32**] bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: [**Electrical**][**Pneumatic**].

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
4. Deceleration: [**0.1 to 999.9**]<**Insert range**> seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.
6. <**Insert adjustment and parameters**>.

J. Self-Protection and Reliability Features:

1. Surge Suppression: [**Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2**][**Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2**].
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC

overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with [**three**]<**Insert number**> selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.
12. <**Insert protection or reliability feature**>.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: [**UL 489, instantaneous-trip circuit breaker**][**UL 489, molded-case switch, with power fuse block and current-limiting fuses**][**UL 489, thermal-magnetic circuit breaker**][**NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses**][**NEMA KS 1, fusible switch**] with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: [**Not less than 115 percent of VFC input current rating**][**Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger**].
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
4. [**NC**][**NO**] alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.

3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. <**Insert condition**>.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last [**four**]<**Insert number**> faults with time and date stamp for each.
5. <**Insert information or display**>.

D. Indicating Devices: Digital display[**and additional readout devices as required,**] mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).
11. <**Insert parameter**>.

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

    a. A minimum of [**two**]<**Insert number**> programmable analog inputs: [**0- to 10-V dc**][**4- to 20-mA dc**][**Operator-selectable "x"- to "y"-mA dc**]<**Insert signal parameters**>.
    b. A minimum of [**six**]<**Insert number**> multifunction programmable digital inputs.

2. Pneumatic Input Signal Interface: **3 to 15 psig (20 to 104 kPa)**.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

    a. 0- to 10-V dc.
    b. 4- to 20-mA dc.

c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.
e. <**Insert signal input**>.

4. Output Signal Interface: A minimum of [**one**]<**Insert number**> programmable analog output signal(s) ([**0- to 10-V dc**][**4- to 20-mA dc**][**operator-selectable "x"- to "y"-mA dc**]<**Insert signal parameters**>), which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).
g. <**Insert indication**>.

5. Remote Indication Interface: A minimum of [**two**]<**Insert number**> programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.
e. <**Insert indication**>.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: [**One**][**Two**]<**Insert number**>.

G. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.

1. Hardwired Points:

a. Monitoring: On-off status, <**Insert monitoring point**>.
b. Control: On-off operation, <**Insert control point**>.

2. Communication Interface: Comply with [**ASHRAE 135**]<**Insert type of interface**>. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. Output Filtering: <**Insert requirements**>.

C. EMI/RFI Filtering:

1. CE marked; certify compliance with IEC 61800-3 for [**Category C2**]<**Insert category**>.
2. <**Insert requirements**>.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode:

1. Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
2. Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

C. Bypass Controller:

1. Two-Contactor-Style Bypass: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller[**; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode**].

   a. Bypass Contactor: Load-break, [**IEC**][**NEMA**]-rated contactor.
   b. Output Isolating Contactor: Non-load-break, [**IEC**][**NEMA**]-rated contactor.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

2. Three-Contactor-Style Bypass: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller[**; with input isolating switch and barrier**] arranged to isolate the power converter input and output and permit safe testing[**and troubleshooting**] of the power converter, both energized and de-energized, while motor is operating in bypass mode.

   a. Bypass Contactor: Load-break, [**IEC**][**NEMA**]-rated contactor.
   b. Input and Output Isolating Contactors: Non-load-break, [**IEC**][**NEMA**]-rated contactors.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: [**Full-voltage (across-the-line)**][**Reduced-voltage (autotransformer)**]<**Insert type**> type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to

allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: [**120**]<**Insert number**>-V ac; obtained from [**integral CPT, with primary and secondary fuses**]<**Insert source of control power**>, with [**CPT**][**control power source**] of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity: [**50**][**100**][**200**]<**Insert number**> VA.

6. Overload Relays: NEMA ICS 2.

    a. Melting-Alloy Overload Relays:

        1) Inverse-time-current characteristic.
        2) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
        3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

    b. Bimetallic Overload Relays:

        1) Inverse-time-current characteristic.
        2) [**Class 10**][**Class 20**][**Class 30**] tripping characteristic.
        3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
        4) Ambient compensated.
        5) Automatic resetting.

    c. Solid-State Overload Relays:

        1) Switch or dial selectable for motor-running overload protection.
        2) Sensors in each phase.
        3) [**Class 10**][**Class 20**][**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
        4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
        5) Analog communication module.

    d. [**NC**][**NO**] isolated overload alarm contact.
    e. External overload, reset push button.

2.7 OPTIONAL FEATURES

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.

1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

B. Damper control circuit with end-of-travel feedback capability.

C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

E. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from [**the firefighter's control station**][**smoke-control fan controller**]<**Insert location**>, this password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
3. Forces VFC to transfer to bypass mode and operate motor at full speed.
4. Causes display of override mode on the VFC display.
5. Reset VFC to normal operation on removal of override signal [**automatically**][**manually**].

F. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

G. Remote digital operator kit.

H. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer[**and a notebook computer**].

I. <**Insert feature**>.

2.8 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: [**Type 1**]<**Insert type**>.
2. Outdoor Locations: [**Type 3R**][**Type 4X**]<**Insert type**>.
3. [**Kitchen**][**Wash-Down**] Areas: [**Type 4X**]<**Insert type**>, [**stainless steel**]<**Insert material**>.
4. Other Wet or Damp Indoor Locations: [**Type 4**]<**Insert type**>.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
6. <**Insert enclosure requirements**>.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.9 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: [**Covered**][**Lockable**][**Shielded**][**Unguarded**].
2. Pilot Lights: Push to test.
3. Selector Switches: [**Rotary**]<**Insert description**> type.
4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. [**NC**][**NO**][**Reversible NC/NO**] bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable [**pneumatic**][**solid-state**] time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, [**Type 4**][**Type 4X**][**Type 12**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, [**Type 3R**][**Type 4X**][**Type 12**]<**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, [**Type 1**][**Type 12**]<**Insert enclosure type**>; UL 508 component recognized: Supply fan, with [**composite**][**stainless steel**]<**Insert material**> intake and exhaust grills [**and filters**]; [**120**]<**Insert number**>-V ac; obtained from [**integral CPT**]<**Insert source of control power**>.

I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

J. Spare control-wiring terminal blocks[**; unwired**][**; wired**].

K. <**Insert accessory**>.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in [**NEMA ICS 61800-2**]<**Insert standard**>.

1. Test each VFC while connected to [**its specified motor**][**a motor that is comparable to that for which the VFC is rated**].
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, <**insert Project-specific conditions,**> and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on **4-inch (100-mm)** nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices[**and facility's central-control system**]. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and

control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation.[**Test and adjust controllers, components, and equipment.**]
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify [**Architect**][**Construction Manager**][**Owner**] before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <**Insert startup steps if any**>.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify [**Architect**][**Construction Manager**][**Owner**] before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges[**as specified in Section 260573.16 "Coordination Studies."**]

F. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 26 29 23 00

SECTION 26 29 33 13 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire pumps - diesel drive, centrifugal.
2. Diesel engine driver.
3. Fire-pump controller - for diesel-drive fire pumps.
4. Fire-pump accessories and specialties.
5. Fire-pump controller remote alarm panel.
6. Fuel oil storage.
7. Grout.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on Project.
2. Section 260010 "Supplemental Requirements for Electrical" specifies requirements applicable to coordinating, scheduling, and sequencing of the electrical Work specified in this Section.

1.2 DEFINITIONS

A. ECM: Electronic control module.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire pump and fire-pump controller.
2. Include rated capacities, operating characteristics, factory-certified performance test curves, electrical characteristics, and furnished accessories and specialties.

B. Shop Drawings: For packaged fire pump and diesel driver, fire-pump controller, and fire-pump accessories and specialties.

1. Provide fabrication and installation details including plans, elevations, sections, and mounting and attachment details.
2. Provide details of equipment assemblies. Indicate dimensions; shipping, installed, and operating weights; loads; required clearances; method of field assembly; components; electrical characteristics; and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Provide wiring diagrams for power, signal, and control wiring.
5. For fire-pump controllers, show the following:

a. Each installed unit's type and details.
b. Enclosure types and details for types other than NEMA 250, Type 2.
c. Factory-installed devices.
d. Nameplate legends.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
f. Specified modifications.

C. Delegated Design Submittals: For fire pump and fire-pump controller.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fire pumps, controllers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of fire pump and fire-pump controller, from manufacturer.

C. Source quality control reports.

D. Field acceptance testing and inspection reports for fire-pump controllers.

E. Field quality control reports.

F. Certified shop test curves showing head capacity and brake horsepower for each pump.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire pumps and fire-pump controllers to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match fire-pump controllers installed and that are packaged with protective coverings for storage and identified with labels describing contents.

1. Auxiliary Contacts: [**One**]<**Insert number**> for each size and type of magnetic contactor installed.
2. Power Contacts: [**Three**]<**Insert number**> for each size and type of magnetic contactor installed.
3. Contactor Coils: [**One**]<**Insert number**> for each size and type of magnetic controller installed.
4. Relay Boards: [**One**]<**Insert number**> for each size and type of relay board installed.
5. Operator Interface: [**One**]<**Insert number**> microprocessor board(s), complete with display and membrane keypad.

6. <**Insert extra materials**>.

1.7 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace fire pumps and controllers that fail in materials or workmanship within specified warranty period.

B. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of fire pumps and controllers, including [**auxiliary contacts for magnetic contactors**][**power contacts for magnetic contactors**][**contactor coils for magnetic contactors**][**relay boards**][**operator interface microprocessor boards**]<**Insert components**> that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire pumps are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**]<**Insert requirement**>[**, NFPA 13**][**, NFPA 14**], and NFPA 20. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria" for building seismic performance criteria.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: 1.5.
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2.2 FIRE PUMPS - DIESEL DRIVE, CENTRIFUGAL

A. Fire Pump - Diesel Drive, End Suction Centrifugal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A C Fire Pump; a Xylem brand**]
b. [**Armstrong Fluid Technology**]
c. [**Patterson Pump Company; a Gorman-Rupp company**]
d. [**Pentair Aurora; Pentair Pump Group**]
e. [**Reddy-Buffaloes Pump Company**]
f. [**Ruhrpumpen, Inc**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**A C Fire Pump; a Xylem brand**]
    b. [**Armstrong Fluid Technology**]
    c. [**Patterson Pump Company; a Gorman-Rupp company**]
    d. [**Pentair Aurora; Pentair Pump Group**]
    e. [**Reddy-Buffaloes Pump Company**]
    f. [**Ruhrpumpen, Inc**]
    g. <**Insert manufacturer's name**>

3. Source Limitations:

    a. Obtain fire pump and diesel drive from single manufacturer.
    b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

4. Description: Factory-fabricated, -assembled, and -tested fire pump and diesel drive.

    a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**]<**Insert minimum pressure**> minimum.
    b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

5. Standards:

    a. Comply with NFPA 20.
    b. <**Insert standard**>.

6. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
7. Pump:

    a. Standard: [**UL 448**]<**Insert standard**>, for end-suction pumps for fire service.
    b. Casing: Top centerline discharge self-venting cast iron with ASME B16.1 pipe-flange connections.
    c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
    d. Wear Rings: Replaceable bronze.
    e. Shaft and Sleeve: Steel shaft with [**bronze**][**stainless steel**] sleeves.

        1) Shaft Bearings: Grease-lubricated, back-to-back thrust ball bearings and one radial roller bearing.
        2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

    f. Mounting: Back pullout design allowing complete rotating assembly removal without disturbing the casing piping connections. Pump and driver shafts are horizontal, with pump and driver on same base.

8. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
9. Driver: Diesel engine.
10. Controller: Diesel engine drive.
11. Capacities and Characteristics:

a. Rated Capacity: <**Insert gpm (L/minute)**>.
b. Total Rated Head: <**Insert feet or psig (kPa)**>.
c. Inlet Flange: [**Class 125**][**Class 250**]<**Insert class**>.
d. Outlet Flange: [**Class 125**][**Class 250**]<**Insert class**>.
e. Suction Head Available at Pump: <**Insert feet (m)**>.
f. Engine Horsepower: <**Insert number**> hp.
g. Engine Speed: <**Insert number**> rpm.
h. Fuel Tank Capacity: <**Insert gal. (L)**>.
i. Pump-Start, Pressure-Switch Setting: <**Insert psig (kPa)**>.
j. Pump-Stop, Pressure-Switch Setting: <**Insert psig (kPa)**>.

12. Source Quality Control:

a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1) Verification of Performance: Rate fire pumps in accordance with UL 448.

b. Prepare test and inspection reports.

B. Fire Pump - Diesel Drive, Split Case, Horizontally Mounted, Single Stage, Centrifugal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A C Fire Pump; a Xylem brand**]
b. [**Armstrong Fluid Technology**]
c. [**Patterson Pump Company; a Gorman-Rupp company**]
d. [**Peerless Pump Company**]
e. [**Pentair Aurora; Pentair Pump Group**]
f. [**Plad Equipment, Ltd.**]
g. [**Reddy-Buffaloes Pump Company**]
h. [**Ruhrpumpen, Inc**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**A C Fire Pump; a Xylem brand**]
b. [**Armstrong Fluid Technology**]
c. [**Patterson Pump Company; a Gorman-Rupp company**]
d. [**Peerless Pump Company**]
e. [**Pentair Aurora; Pentair Pump Group**]
f. [**Plad Equipment, Ltd.**]
g. [**Reddy-Buffaloes Pump Company**]
h. [**Ruhrpumpen, Inc**]
i. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain fire pump and diesel drive from single manufacturer.
b. Equipment provider is to provide services of a factory authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

4. Description: Factory-fabricated, -assembled, and -tested fire-pump and diesel drive.

    a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**]<**Insert minimum pressure**> minimum.
    b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

5. Standards:

    a. Comply with NFPA 20.
    b. <**Insert standard**>.

6. Base: Fabricated and attached to fire pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
7. Pump:

    a. Standard: [**UL 448**]<**Insert standard**>, for split-case pumps for fire service.
    b. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
    c. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
    d. Wear Rings: Replaceable bronze.
    e. Shaft and Sleeve: Alloy-steel shaft with bronze sleeve.

        1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
        2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

    f. Mounting: Horizontal pump and driver shafts with pump and driver on same base.

8. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
9. Driver: Diesel engine.
10. Controller: Diesel engine drive.
11. Capacities and Characteristics:

    a. Rated Capacity: <**Insert gpm (L/minute)**>.
    b. Total Rated Head: <**Insert feet or psig (kPa)**>.
    c. Inlet Flange: [**Class 125**][**Class 250**]<**Insert class**>.
    d. Outlet Flange: [**Class 125**][**Class 250**]<**Insert class**>.
    e. Suction Head Available at Pump: <**Insert feet (m)**>.
    f. Engine Horsepower: <**Insert number**> hp.
    g. Engine Speed: <**Insert number**> rpm.
    h. Fuel Tank Capacity: <**Insert gal. (L)**>.
    i. Pump-Start, Pressure-Switch Setting: <**Insert psig (kPa)**>.
    j. Pump-Stop, Pressure-Switch Setting: <**Insert psig (kPa)**>.
    k. Rotation [**Clockwise**][**Counterclockwise**].

12. Source Quality Control:

    a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

        1) Verification of Performance: Rate fire pumps in accordance with UL 448.

    b. Prepare test and inspection reports.

C. Fire Pump - Diesel Drive, Split Case, Horizontally Mounted, Two Stage, Centrifugal:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**A C Fire Pump; a Xylem brand**]
   b. [**Patterson Pump Company; a Gorman-Rupp company**]
   c. [**Peerless Pump Company**]
   d. [**Pentair Aurora; Pentair Pump Group**]
   e. [**Ruhrpumpen, Inc**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**A C Fire Pump; a Xylem brand**]
   b. [**Patterson Pump Company; a Gorman-Rupp company**]
   c. [**Peerless Pump Company**]
   d. [**Pentair Aurora; Pentair Pump Group**]
   e. [**Ruhrpumpen, Inc**]
   f. <**Insert manufacturer's name**>

3. Source Limitations:

   a. Obtain fire pump and diesel driver from single manufacturer.
   b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

4. Description: Factory-fabricated, -assembled, and -tested fire pump and diesel drive.

   a. Pump Equipment, Accessory, and Specialty Pressure Rating: [**175 psig (1200 kPa)**]<**Insert minimum pressure**> minimum.
   b. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

5. Standards:

   a. Comply with NFPA 20.
   b. <**Insert standard**>.

6. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
7. Pump:

   a. Standard: [**UL 448**]<**Insert standard**>, for split-case pumps for fire service.
   b. Number Stages: Two.
   c. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
   d. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
   e. Wear Rings: Replaceable bronze.
   f. Shaft and Sleeve: Alloy-steel shaft with bronze sleeve.

      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn

and bronze packing gland.

g. Mounting: Horizontal pump and driver shafts with pump and driver on same base.

8. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
9. Driver: Diesel engine.
10. Controller: Diesel engine drive.
11. Capacities and Characteristics:

    a. Rated Capacity: <**Insert gpm (L/minute)**>.
    b. Total Rated Head: <**Insert feet or psig (kPa)**>.
    c. Inlet Flange: [**Class 125**][**Class 250**]<**Insert class**>.
    d. Outlet Flange: [**Class 125**][**Class 250**]<**Insert class**>.
    e. Suction Head Available at Pump: <**Insert feet (m)**>.
    f. Engine Horsepower: <**Insert number**> hp.
    g. Engine Speed: <**Insert number**> rpm.
    h. Fuel Tank Capacity: <**Insert gal. (L)**>.
    i. Pump-Start, Pressure-Switch Setting: <**Insert psig (kPa)**>.
    j. Pump-Stop, Pressure-Switch Setting: <**Insert psig (kPa)**>.

12. Source Quality Control:

    a. Manufacturer Testing: Test and inspect fire pumps in accordance with UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

        1) Verification of Performance: Rate fire pumps in accordance with UL 448.

    b. Prepare test and inspection reports.

2.3 DIESEL ENGINE DRIVER

A. Diesel Engine Driver:

1. Fuel: Fuel oil, [**Grade DF-2**]<**Insert grade**>.
2. Horsepower Rating: Not less than 110 percent of maximum brake horsepower (after derating for temperature and elevation in accordance with NFPA 20).
3. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
4. Controls:

    a. Adjustable governor.
    b. Over-speed shutdown.
    c. Manual reset, speed switch.
    d. Instrument panel with tachometer, oil pressure gauge, water temperature gauge, and hour meter.

5. Fuel System:

    a. Comply with NFPA 20.
    b. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
    c. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

d. Flexible metallic fuel lines.
e. Inline fuel filter.
f. Oil pressure safety switch.
g. Air cleaner.
h. Engine-driven oil pump.
i. Enclosed control wiring electric starter with voltage regulator.
j. Storage Tank:[**Double wall,**] size indicated, but not less than required by NFPA 20; with floor legs, direct-reading level gauge[**, and secondary containment tank having capacity at least equal to storage tank**].

6. Exhaust System:

a. Piping: ASTM A53/A53M, Type E or S, Schedule 40 black steel pipe; ASME B16.9 weld-type pipe fittings; ASME B16.5 steel flanges; and ASME B16.21 nonmetallic gaskets.
b. Fabricate double-wall, ventilated thimble from steel pipe.
c. Flexible exhaust connector.
d. [**Industrial-**][**Residential-**][**Critical-**][**Super Critical-**][**Hospital-**][**Hospital Plus-**][**Extreme-**] grade exhaust silencer with spark arrestor.

7. Rated Engine Speed: 1800 rpm.
8. Maximum Piston Speed for Four-Cycle Engines: **2250 fpm (11.4 m/s)**.
9. Engine- or Skid-Mounted Lubrication System:

a. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
b. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit is to be capable of full flow and is designed to be fail-safe.
c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

10. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system.
11. Cooling System, Factory-Mounted Radiator:

a. Factory installed, closed loop, liquid cooled, with radiator factory mounted on fire-pump mounting frame and integral engine-driven coolant pump.
b. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
c. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
d. Expansion Tank: Constructed of welded-steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gauge glass and petcock.
e. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
f. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

1) Rating: **50 psig (345 kPa)** maximum working pressure, with coolant at **180 deg F (82 deg C)**, and noncollapsible under vacuum.
2) End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

12. Cooling System, Remote Radiator:

a. Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
b. Configuration: [**Vertical**][**Horizontal**] air discharge.

c. Radiator Core Tubes: [**Aluminum**][**Nonferrous-metal construction other than aluminum**].
d. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
e. Expansion Tank: Constructed of welded-steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gauge glass and petcock.
f. Fan: Driven by [**multiple belts from engine shaft**][**totally enclosed electric motor with sealed bearings**].
g. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
h. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

13. Muffler/Silencer, Industrial Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**15 dBA**]<**Insert dBA**> at 500 Hz.
    b. Sound level measured at a distance of [**25 ft. (8 m)**]<**Insert distance**> from exhaust discharge after installation is complete is to be [**85**]<**Insert number**> dBA or less.

14. Muffler/Silencer, Residential Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**20 dBA**]<**Insert dBA**> at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**]<**Insert distance**> from exhaust discharge after installation is complete is to be [**85**]<**Insert number**> dBA or less.

15. Muffler/Silencer, Critical Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**25 dBA**]<**Insert dBA**> at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**]<**Insert distance**> from exhaust discharge after installation is complete is to be [**85**]<**Insert number**> dBA or less.

16. Muffler/Silencer, Super Critical Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**30 dBA**]<**Insert dbA**> at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**]<**Insert distance**> from exhaust discharge after installation is complete is to be [**85**]<**Insert number**> dBA or less.

17. Muffler/Silencer, Hospital Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of [**35 dBA**]<**Insert dBA**> at 500 Hz.
    b. Sound level measured at a distance of [**10 ft. (3 m)**]<**Insert distance**> from exhaust discharge after installation is complete is to be [**85**]<**Insert number**> dBA or less.

18. Muffler/Silencer, Hospital Plus Grade: Sized as recommended by engine manufacturer and

selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

a. Minimum sound attenuation of [**35 dBA**]<**Insert dBA**> at 500 Hz.
b. Sound level measured at a distance of [**10 ft. (3 m)**]<**Insert distance**> from exhaust discharge after installation is complete is to be [**85**]<**Insert number**> dBA or less.

19. Muffler/Silencer, Extreme Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

a. Minimum sound attenuation of [**40 dBA**]<**Insert dBA**> at 500 Hz.
b. Sound level measured at a distance of [**10 ft. (3 m)**]<**Insert distance**> from exhaust discharge after installation is complete is to be [**85**]<**Insert number**> dBA or less.

20. Muffler/Silencer, Super Extreme Grade: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

a. Minimum sound attenuation of [**45 dBA**]<**Insert dBA**> at 500 Hz.
b. Sound level measured at a distance of [**10 ft. (3 m)**]<**Insert distance**> from exhaust discharge after installation is complete is to be [**85**]<**Insert number**> dBA or less.

21. Air-Intake Filter: [**Standard**][**Heavy**]-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
22. Starting System: [**12**][**24**]-V dc, with negative ground.

a. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
b. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
c. Cranking Cycle: [**60**]<**Insert number**> seconds.
d. Battery: Adequate capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least [**twice**][**three times**] without recharging.
e. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
f. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater is to be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place.
g. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
h. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit is to comply with UL 1236 and include the following features:

1) Operation: Equalizing-charging rate of 10 A is to be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit is then to be automatically switched to a lower float-charging mode and is to continue to operate in that mode until battery is discharged again.
2) Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
3) Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

4) Ammeter and Voltmeter: Flush mounted in door. Meters are to indicate charging rates.
5) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition is to close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
6) Enclosure and Mounting: NEMA 250, Type 1 wall-mounted cabinet.

2.4 FIRE-PUMP CONTROLLER - FOR DIESEL-DRIVE FIRE PUMPS

A. Fire-Pump Controllers - For Diesel-Drive Fire Pumps:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Firetrol**]
c. [**Master Control Systems, Inc**]
d. [**Metron Eledyne; a Hubbell Company**]
e. [**Tornatech**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Firetrol**]
c. [**Master Control Systems, Inc**]
d. [**Metron Eledyne; a Hubbell Company**]
e. [**Tornatech**]
f. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain diesel-drive controllers from single manufacturer.
b. Equipment provider is to provide services of a factory authorized service representative and have a service facility located within a **60-mile (100-km)** radius of Project site.

4. Description:

a. Factory fabricated, assembled, wired, and tested.
b. Operation: [**Combined automatic and nonautomatic**][**Nonautomatic**] operation.

5. Standards:

a. Comply with NFPA 20.
b. <**Insert standard**>.

6. Method of Starting:

a. Actuation: [**Pressure**][**Nonpressure**]-switch actuated.

1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
2) Programmable minimum-run-time relay to prevent short cycling.
3) Programmable timer for weekly tests.

b. Dual, redundant dc-voltage battery units, with automatic changeover.
c. Emergency Control: Bypasses automatic control circuits during manual starting and running.
d. Automatic engine start on loss of ac power to the controller.

7. Method of Stopping: [**Automatic and nonautomatic shutdown after automatic starting**][**Nonautomatic**].
8. Enclosure:

a. NEMA 250, Type [**2**][**3R**][**4**][**4X**][**12**]<**Insert type**> minimum.

1) Comply with environmental conditions at installed location and NFPA 20.

b. Enclosure Color: [**Manufacturer's standard "fire-pump-controller red"**]<**Insert color**>.
c. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
d. Features:

1) Floor stands, **12 inches (305 mm)** high, for floor-mounted controllers.
2) Space heater, [**120 V(ac)**][**240 V(ac)**][**, with humidistat**][**, with thermostat**].
3) Tropicalization.
4) <**Insert optional feature**>.

9. Door-Mounted Operator Interface and Controls:

a. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.

1) Pressure and Event Recorder capable of logging pressure data and operational events with time and date stamp for the life of the controller. Data to be retrievable and downloadable to a flash memory drive via a USB port accessible to the user without having to open the controller door.

b. Touch Screen Operator Interface:

1) Provide minimum 7-inch LCD Color Touch Screen powered by an embedded microprocessor with software.
2) Provide in addition to push-button operation for START/STOP/RUN TEST and graphic display of system operations, the control is to allow programming of Cut-In and Cut-Out pressures, Minimum Runtime and is to allow for on-screen viewing of corresponding Owner's Manual in chosen language.

c. Local and Remote Alarm and Status Indications:

1) Status LEDs - green color for the following:

a) Low Pressure.
b) Engine Run.

c) Remote Start.
d) Interlock On.
e) Deluge Valve (if applicable).
f) One Programmable LED.

2) Alarm LEDs - red color for the following:

a) Battery #1 Failure.
b) Charger #1 Failure.
c) Battery #2 Failure.
d) Charger #2 Failure
e) Low Pressure.
f) System Over Pressure.
g) Low Suction Pressure.
h) Low Fuel.
i) Fail to Start.
j) High Engine Temp.
k) Low Oil Pressure.
l) Engine Over Speed.
m) ECM Selector in Alt Position.
n) Fuel Injection Malfunction.
o) ECM Warning.
p) ECM Failure.
q) High Raw Water Temp.
r) Low Engine Temperature
s) Fuel Spill
t) One Programmable LED.

d. Audible alarm with Push to Silence button.
e. Nonautomatic START and STOP push buttons or switches.
f. Set pressure and system pressure.
g. <**Insert function**>.

10. Features:

a. Extra Output Contacts:

1) [**One**]<**Insert number**> Form C contact(s) for low pump-room temperature.
2) [**One**]<**Insert number**> each, Form C contact(s) for high and low fuel levels.
3) [**One**]<**Insert number**> each, Form C contact(s) for high and low reservoir levels.
4) <**Insert contact type**>.

b. Operator Interface Communications Ports: USB, Ethernet, and TIA-485-A.
c. Communications Protocol Capability: Modbus with TCP/IP frame format and shielded female RJ45 connector.
d. Powered louver contacts.
e. Powered engine-oil heater contacts.
f. <**Insert optional feature**>.

11. Battery Charger System:

a. Built-in, independent, dual battery chargers with automatic changeover; [**12 V(dc)**][**24 V(dc)**] for [**lead-acid**][**nickel-cadmium**] batteries.
b. Standard: [**UL 1236**]<**Insert standard**>.

12. Source Quality Control:

    a. Manufacturer Testing: Test and inspect fire-pump controllers in accordance with requirements in NFPA 20 and [**UL 218**]<**Insert standard**>.

        1) Verification of Performance: Rate controllers in accordance with operation of functions and features specified.

    b. Prepare test and inspection reports.

2.5 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, bronze or cast iron, spring loaded; for installation in pump-discharge piping.

C. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

D. Outlet Fitting: Concentric tapered reducer at pump-discharge outlet.

E. Discharge Cone: [**Closed**][**Open**][**Closed or open**] type.

F. Fire-Pump Relief Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**BERMAD Control Valves**]
    b. [**CLA-VAL**]
    c. [**Kunkle Valve**]
    d. [**OCV Control Valves**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. [**Zurn Industries, LLC**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**BERMAD Control Valves**]
    b. [**CLA-VAL**]
    c. [**Kunkle Valve**]
    d. [**OCV Control Valves**]
    e. [**WATTS; A Watts Water Technologies Company**]
    f. [**Zurn Industries, LLC**]
    g. <**Insert manufacturer's name**>

3. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

G. Fire-Pump Test Connection:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**American Fire Supply**]
    b. [**CLA-VAL**]
    c. [**Croker; a Division of Morris Group International**]
    d. [**Guardian Fire Equipment, Inc**]
    e. [**Potter Roemer LLC; a Division of Morris Group International**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Fire Supply**]
    b. [**CLA-VAL**]
    c. [**Croker; a Division of Morris Group International**]
    d. [**Guardian Fire Equipment, Inc**]
    e. [**Potter Roemer LLC; a Division of Morris Group International**]
    f. <**Insert manufacturer's name**>

3. Standards:

    a. NFPA 20.
    b. UL 405, except outlets without clappers instead of inlets.

4. Description: [**Exposed, projecting, for wall mounting**][**Flush, for wall mounting**]<**Insert type**>.
5. Pressure Rating: **175 psig (1200 kPa)** minimum.
6. Body Material: Corrosion-resistant metal with number of outlets required by NFPA 20.
7. Escutcheon Plate: Brass or bronze.
8. Hose Valves: UL 668, bronze, with outlet threaded in accordance with NFPA 1963 and matching local fire-department threads. Include caps and chains.
9. Exposed Parts Finish: [**Polished**][**Rough**][**brass**][**, chrome plated**].
10. Escutcheon Plate Marking: [**FIRE-PUMP TEST CONNECTION**]<**Insert marking**>

H. Fire-Pump Flowmeter Systems:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Fire Research Corp**]
    b. [**Gerand Engineering Co**]
    c. [**Hyspan Precision Products, Inc**]
    d. [**Victaulic Company**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Fire Research Corp**]

b. [**Gerand Engineering Co**]
c. [**Hyspan Precision Products, Inc**]
d. [**Victaulic Company**]
e. <**Insert manufacturer's name**>

3. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
4. Pressure Rating: [**175 psig (1200 kPa) minimum**][**250 psig (1725 kPa)**][**300 psig (2070 kPa)**]<**Insert pressure**>.
5. Sensor: [**Venturi**][**Paddlewheel**]<**Insert type**>. Sensor size is to match pipe, tubing, flowmeter, and fittings.
6. Permanently Mounted Flowmeter: Compatible with flow sensor, with dial not less than **4-1/2 inches (115 mm)** in diameter.[**Include bracket or device for wall mounting.**]

   a. Tubing Package: **NPS 1/8 or NPS 1/4 (DN 6 or DN 10)** plastic tubing with copper or brass fittings and valves.

7. Portable Flowmeter: Compatible with flow sensor, with dial not less than **4-1/2 inches (115 mm)** in diameter and with two **12-ft.- (3.7-m-)** long hoses in carrying case.

2.6 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Day Tank: UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin, with a capacity of 150 percent of nominal capacity of day tank.

   a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: [**As recommended by engine manufacturer**]<**Insert gallons (liters)**>.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

C. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.
2. Capacity: Fuel for [**eight**]<**Insert number**> hours' continuous operation at 100 percent rated power output.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.7 FIRE-PUMP CONTROLLER REMOTE ALARM PANEL

A. Fire-Pump Controller Remote Alarm Panel:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Eaton**]
    b. [**Firetrol**]
    c. [**Master Control Systems, Inc**]
    d. [**Metron Eledyne; a Hubbell Company**]
    e. [**Tornatech**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Eaton**]
    b. [**Firetrol**]
    c. [**Master Control Systems, Inc**]
    d. [**Metron Eledyne; a Hubbell Company**]
    e. [**Tornatech**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain remote alarm panels from single manufacturer.
4. Standards:

    a. Comply with NFPA 20.
    b. <**Insert standard**>.

5. Description: Factory fabricated, assembled, wired, and tested.
6. Supervisory and Normal Control Voltage: [**120 V(ac)**][**240 V(ac)**]<**Insert voltage**>; [**single**][**dual**] source.
7. Audible and Visual Alarm and Status Indications for Diesel-Driven Pump Controllers:

    a. Normal Power On.
    b. Supervisory Power On.
    c. Engine Running.
    d. Not in Auto Mode.
    e. Low Fuel.
    f. Common Alarm.
    g. <**Insert alarm**>.
    h. <**Insert alarm**> with SPDT, 8 Amp relay Output.

8. Audible alarm, with silence push button.

2.8 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink and recommended for interior and exterior applications.

C. Design Mix: **5000 psi (34 MPa)**, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces to receive equipment, equipment bases and anchorage provisions, with installing contractor(s)[**, Architect,**][**, Engineer,**][**, Construction Manager,**] and Manufacturer's Representative present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the fire pump and fire-pump controller.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

C. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PROTECTION OF FIRE-PUMP CONTROLLERS

A. Temporary Heating: Apply temporary heat to maintain temperature in accordance with manufacturer's written instructions until enclosed fire-pump controllers are ready to be energized and placed into service.

B. Replace fire-pump controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.3 INSTALLATION OF FIRE PUMPS

A. Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting:

1. Install fire pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."
3. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately, so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 211000 "Water-Based Fire-Suppression Systems."

F. Install pressure gauges on fire-pump suction and discharge flange pressure-gauge tappings. Comply with requirements for pressure gauges specified in Section 211000 "Water-Based Fire-Suppression Systems."

G. Install piping hangers and supports, anchors, valves, gauges, and equipment supports in accordance with NFPA 20[**, NFPA 13,**][**and**][**NFPA 14**]<**Insert standard**>.

H. Install fuel system in accordance with NFPA 20.

I. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.

J. Install exhaust-system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.

K. Install condensate-drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.

L. Install flowmeters and sensors. Install flowmeter-system components and make connections in accordance with NFPA 20 and manufacturer's written instructions.

M. Electrical Wiring: Install electrical devices furnished by equipment manufacturers that are not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.4 ALIGNMENT OF FIRE PUMPS

A. Align [**end-suction**][**and**][**split-case**] pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment in accordance with HI 1.4 and to tolerances specified by manufacturer.

3.5 PIPING CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 211000 "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect flowmeter-system meters, sensors, and valves to tubing.

E. Connect fire pumps to their controllers.

3.6 INSTALLATION OF FIRE-PUMP CONTROLLERS

A. Coordinate installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access

doors and panels. Ensure that controllers are within sight of fire-pump drivers.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Install controllers within sight of their respective drivers.

D. Connect controllers to their dedicated pressure-sensing lines.

E. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than **79 inches (2 m)** above finished floor, and bottom of enclosure not less than **12 inches (305 mm)** above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

F. Floor-Mounting Controllers: Install controllers on concrete base(s), using floor stands high enough so that the bottom of enclosure cabinet is not less than **12 inches (305 mm)** above finished floor. Comply with requirements for concrete bases specified in Section 260529 "Hangers and Supports for Electrical Systems."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems" and Section 018123 "Facility Seismic and Wind Criteria."

H. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

I. Installation of Control and Alarm Wiring:

1. Install wiring between fire-pump controllers and remote devices[**and facility's central monitoring system**]. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."
2. Install wiring between remote alarm panels and fire-pump controllers. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."
3. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 284600 "Fire Detection and Alarm."
4. Bundle, train, and support wiring in enclosures.
5. Connect remote manual and automatic activation devices where applicable.

J. Field Acceptance Testing and Inspection.

1. Acceptance Testing Preparation:

a. Inspect and Test Each Component:

1) Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
2) Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
3) Test continuity of each circuit.

2. Representatives from manufacturers of fire-pump controllers must be present during acceptance

tests and inspections in accordance with NFPA 20.

3. Acceptance tests and inspections must be witnessed by [**Architect**][**Construction Manager**][**Owner**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.
4. Acceptance Tests and Inspections:

    a. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to [**Architect**][**Construction Manager**][**Owner**] and authorities having jurisdiction.
    b. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
    c. Engage manufacturer's factory-authorized service representative to be present during the testing.
    d. Perform field acceptance tests as outlined in NFPA 20.

5. Nonconforming Work:

    a. Controllers will be considered defective if they do not pass tests and inspections.
    b. Remove and replace defective units with new units and retest.

6. Prepare and submit field acceptance testing and inspection reports.

3.7 INSTALLATION OF FIRE-PUMP CONTROLLER REMOTE ALARM PANEL

A. Install panels on walls with tops not higher than [**72 inches (1829 mm)**]<**Insert height**> above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For panels not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

3.8 IDENTIFICATION OF FIRE PUMPS AND FIRE-PUMP CONTROLLERS

A. Comply with NFPA 20 requirements for marking of fire pumps and fire-pump controllers.

B. Identify equipment, system components, piping, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment and Section 260553 "Identification for Electrical Systems."

3.9 STARTUP SERVICE FOR FIRE PUMPS AND CONTROLLERS

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. <**Insert startup steps**>.

3.10 ADJUSTING

A. Adjust fire-pump controllers and battery charger systems to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Set field-adjustable pressure switches.

3.11 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
2. Test in accordance with NFPA 20 for acceptance and performance testing.

    a. Prior to initial startup and acceptance testing, complete and check all electric wiring serving fire-pump controller and pressure-maintenance pump motor including control interwiring, normal power, and alternate power.

3. Leak Test: After installation, fill system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

G. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain fire pumps, and fire-pump controllers.

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SECTION 26 29 33 13A - PRESSURE-MAINTENANCE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pressure-maintenance pumps - vertical, multistage.
2. Pressure-maintenance pumps - vertical turbine.
3. Pressure-maintenance pump controllers.
4. Grout.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on Project.
3. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" specifies seismic restraint and vibration isolation of fire suppression equipment and piping.
4. Section 260010 "Supplemental Requirements for Electrical" specifies requirements applicable to coordinating, scheduling, and sequencing of the electrical Work specified in this Section.
5. Section 260573 "Power System Studies" specifies arc flash hazard analyses and arc flash hazard labeling.
6. Section 284600 "Fire Detection and Alarm" specifies supervisory connections to fire-alarm systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for pressure-maintenance pump and pressure-maintenance pump controller.
2. Include rated capacities, operating characteristics, factory-certified performance test curves, electrical characteristics, and furnished accessories and specialties.

B. Shop Drawings: For pressure-maintenance pumps, pressure-maintenance pump controllers, and pressure-maintenance pump accessories and specialties.

1. Provide fabrication and installation details, including plans, elevations, sections, and mounting and attachment details.
2. Provide details of equipment assemblies. Indicate dimensions; shipping, installed, and operating weights; loads; required clearances; method of field assembly; components; electrical characteristics; and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Provide wiring diagrams for power, signal, and control wiring.
5. For pressure-maintenance pump controllers, show the following:

a. Each installed unit's type and details.
b. Enclosure types and details for types other than NEMA, Type 2.
c. Factory-installed devices.
d. Nameplate legends.
e. Short-circuit current rating of integrated unit.
f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
g. Specified modifications.

C. Delegated Design Submittal: For pressure-maintenance pump and pressure-maintenance pump controller.

1. Include design calculations for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For pressure-maintenance pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of pressure-maintenance pump and pressure-maintenance pump controller, from manufacturer.

C. Source quality-control reports.

D. Field-acceptance testing and inspection reports for fire-pump controllers.

E. Field quality-control reports.

F. Certified shop test curves showing head capacity and brake horsepower for each pump.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure-maintenance pumps and pressure-maintenance pump controllers to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Auxiliary Contacts: [**One**]<**Insert number**> for each size and type of magnetic contactor installed.
2. Power Contacts: [**Three**]<**Insert number**> for each size and type of magnetic contactor installed.
3. Contactor Coils: [**One**]<**Insert number**> for each size and type of magnetic controller installed.

4. Relay Boards: [**One**]<**Insert number**> for each size and type of relay board installed.
5. Operator Interface: [**One**]<**Insert number**> microprocessor board(s), complete with display and membrane keypad.
6. <**Insert extra materials**>.

1.6 WARRANTY

A. Manufacturer Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace pressure-maintenance pumps and controllers that fail in materials or workmanship within specified warranty period.

B. Special Warranty: [**Manufacturer agrees**][**Installer agrees**][**Manufacturer and Installer agree**] to repair or replace components of pressure-maintenance pumps and controllers, including [**auxiliary contacts for magnetic contactors**][**power contacts for magnetic contactors**][**contactor coils for magnetic contactors**][**relay boards**][**operator interface microprocessor boards**]<**Insert components**> that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Pressure-maintenance pumps are to withstand the effects of earthquake motions determined in accordance with NFPA 20 [**and**][**ASCE/SEI 7**][**NFPA 13**][**NFPA 14**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: 1.5.
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by a qualified electrical testing agency recognized by authorities having jurisdiction and marked for intended location and application.

2.2 PRESSURE-MAINTENANCE PUMPS

A. Pressure-Maintenance Pumps - Vertical, Multistage:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**A C Fire Pump; a Xylem brand**]
b. [**Armstrong Fluid Technology**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**A C Fire Pump; a Xylem brand**]
b. [**Armstrong Fluid Technology**]
c. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain vertical, multistage, pressure-maintenance pump and electric drive from single manufacturer.
b. Equipment provider is to provide services of a factory authorized service representative and have a service facility located within a **60-mile (100 km)** radius of Project site.

4. Description: Factory-fabricated, -assembled, and -tested, multistage, barrel-type vertical pressure-maintenance pump, as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.
5. Pump Construction:

a. Barrel: Stainless steel.
b. Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
c. Pump Head/Motor Mount: Cast iron.
d. Impellers: Stainless steel, balanced, and keyed to shaft.
e. Pump Shaft: Stainless steel.
f. Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.
g. Wear Rings: Teflon.
h. Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
i. Chamber-Base Bearing: Tungsten carbide.
j. O-Rings: [**EPDM**][**NBR**][**Viton**].

6. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 210500 "Common Work Results for Fire Suppression."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Description: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head.

7. Nameplate: Permanently attached to pump and indicating capacity and characteristics.
8. Capacities and Characteristics:

a. Rated Capacity: <**Insert gpm (L/minute)**>.
b. Total Dynamic Head: <**Insert feet (kPa)**>.
c. Working Pressure: [**175 psig (1200 kPa) minimum**][**230 psig (1586 kPa)**][**300 psig (2070 kPa)**]<**Insert value**>.
d. Inlet and Outlet Size: [**NPS 1-1/4 (DN 32)**]<**Insert size**>.
e. Discharge and Suction Flanges: [**Class 250**]<**Insert class**>.
f. Suction Head Available at Pump: <**Insert ft. (m)**>.
g. Motor Horsepower: <**Insert value**>.
h. Motor Speed: <**Insert rpm**>.
i. Electrical Characteristics:

1) Volts: [**120**][**208**]<**Insert value**>.
2) Phases: [**Single**][**Three**].
3) Hertz: [**60**]<**Insert value**>.

4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

j. Pump-Start, Pressure-Switch Setting: <**Insert psig (kPa)**>.
k. Pump-Stop, Pressure-Switch Setting: <**Insert psig (kPa)**>.

B. Pressure-Maintenance Pumps - Vertical Turbine:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Armstrong Fluid Technology**]
b. [**Aurora Pump; Pentair Ltd.**]
c. [**Patterson Pump Company; a Gorman-Rupp company**]
d. [**Peerless Pump Company**]
e. [**Ruhrpumpen, Inc**]
f. [**Sulzer Pumps Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Armstrong Fluid Technology**]
b. [**Aurora Pump; Pentair Ltd.**]
c. [**Patterson Pump Company; a Gorman-Rupp company**]
d. [**Peerless Pump Company**]
e. [**Ruhrpumpen, Inc**]
f. [**Sulzer Pumps Inc.**]
g. <**Insert manufacturer's name**>

3. Source Limitations:

a. Obtain vertical-turbine, pressure-maintenance pump and driver from single manufacturer.
b. Equipment provider is to provide services of a factory-authorized service representative and have a service facility located within a **60-mile (100 km)** radius of Project site.

4. Description: Factory-fabricated, -assembled, and -tested, vertical, multistate, open-line-shaft turbine pressure-maintenance pump, as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted above pump head.
5. Pump Construction:

a. Pump Head: Cast iron, for surface discharge, with flange, except connections may be threaded in sizes in which flanges are not available.
b. Pump Head Seal: Stuffing box and stuffing.
c. Line Shaft and Bearings for Water-Lubricated Bearings: Static water levels of **50 ft. (15 m)** or less.

1) Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
2) Line Shaft Bearings: Rubber sleeve, water lubricated.

d. Line Shaft and Bearings for Oil-Lubricated Bearings: Static water levels between **50 and 200 ft. (15 and 61 m)**.

1) Line Shaft: Steel.
2) Line Shaft Bearings: Corrosion resistant, oil lubricated.

e. Impeller Shaft: Monel metal or stainless steel.
f. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
g. Column Pipe: ASTM A53/A53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections **10 ft. (3 m)** or less, with strainer of cast or fabricated bronze or stainless steel at bottom.

6. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 210500 "Common Work Results for Fire Suppression."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Description: Single speed with permanently lubricated ball bearings.

7. Base: Cast iron or steel with hole for electrical cable.
8. Nameplate: Permanently attached to pump and indicating capacity and characteristics.
9. Capacities and Characteristics:

a. Rated Capacity: <**Insert gpm (L/minute)**>.
b. Total Dynamic Head: <**Insert feet (kPa)**>.
c. Working Pressure: <**Insert psig (kPa)**>.
d. Inlet Column Size: <**Insert NPS (DN)**>.
e. Pump Column Length: <**Insert feet (m)**>.
f. Outlet Size: <**Insert NPS (DN)**>.
g. Flange: [**Class 125**]<**Insert class**>.
h. Suction Head Available at Pump: <**Insert feet (m)**>.
i. Motor Horsepower: <**Insert value**>.
j. Motor Speed: <**Insert rpm**>.
k. Electrical Characteristics:

1) Volts: [**120**][**208**]<**Insert value**>.
2) Phases: [**Single**][**Three**].
3) Hertz: [**60**]<**Insert value**>.
4) Full-Load Amperes: <**Insert value**>.
5) Minimum Circuit Ampacity: <**Insert value**>.
6) Maximum Overcurrent Protection: <**Insert amperage**>.

l. Pump-Start, Pressure-Switch Setting: <**Insert psig (kPa)**>.
m. Pump-Stop, Pressure-Switch Setting: <**Insert psig (kPa)**>.

2.3 PRESSURE-MAINTENANCE PUMP CONTROLLERS

A. Pressure-Maintenance Pump Controller:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Eaton**]
b. [**Firetrol**]

c. [**Master Control Systems, Inc**]
d. [**Metron Eledyne; a Hubbell Company**]
e. [**Tornatech**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Eaton**]
b. [**Firetrol**]
c. [**Master Control Systems, Inc**]
d. [**Metron Eledyne; a Hubbell Company**]
e. [**Tornatech**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain pressure-maintenance pump controllers from a single manufacturer.
4. Description:

a. Type: UL 508A, factory-assembled, -wired, and -tested, across-the-line controller; for combined automatic and manual operation.
b. Enclosure: NEMA, Type 2 for wall mounting.
c. Finish: Manufacturer's standard color paint.

5. Standards:

a. Listed in accordance with UL 508A.
b. <**Insert standard**>.

6. Rate controller for scheduled horsepower and include the following:

a. Fusible disconnect switch.
b. Pressure switch.
c. Hand-off-auto selector switch.
d. Pilot light.
e. Running period timer.

2.4 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink and recommended for interior and exterior applications.

C. Design Mix: **5000 psi (34 MPa)**, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surface to receive equipment, equipment bases and anchorage provisions, with Installing Contractor(s), [**Architect**][**engineer**][**Construction Manager**][**and**] Manufacturer's Representative present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the pressure-maintenance pump and pressure-maintenance pump controller.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before pressure-maintenance pump installation.

C. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PROTECTION OF PRESSURE-MAINTENANCE PUMP CONTROLLERS

A. Replace pressure-maintenance pump controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.3 INSTALLATION OF PRESSURE-MAINTENANCE PUMPS

A. Comply with NFPA 20 for installation of pressure-maintenance pumps.

B. Equipment Mounting:

1. Install multistage pressure-maintenance pumps in accordance with HI 1.4.
2. Install vertical-turbine, pressure-maintenance pumps in accordance with HI 2.4.
3. Install base-mounted pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
4. Comply with requirements for vibration isolation and seismic control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."
5. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Support piping and pumps separately, so weight of piping does not rest on pumps.

D. Install isolation valves in both inlet and outlet pipes near the pump. Comply with requirements for valves specified in Section 211000 "Water-Based Fire-Suppression Systems."

E. Install piping hangers and supports, anchors, valves, gauges, and equipment supports in accordance with NFPA 20 [**NFPA 13**][**and**][**NFPA 14**]<**Insert standard**>.

F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.4 PIPING CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 211000 "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect pressure-maintenance pumps to their controllers

3.5 INSTALLATION OF PRESSURE-MAINTENANCE-PUMP CONTROLLERS

A. Coordinate installation of controllers with other construction, including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of pressure-maintenance-pump drivers.

B. Connect controllers to their dedicated pressure-sensing lines.

C. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than **79 inches (2 m)** above finished floor, and bottom of enclosure not less than **12 inches (305 mm)** above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" and Section 018123 "Facility Seismic and Wind Criteria."

E. Installation of Power Wiring:

1. Install power wiring between pressure-maintenance-pump controllers and their services or sources, and between pressure-maintenance-pump controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70 (including Article 695, "Fire Pumps"), and Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

F. Field-Acceptance Testing and Inspection.

1. Acceptance Testing Preparation:

a. Inspect and Test Each Component:

1) Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
2) Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
3) Test continuity of each circuit.

b. Verify and Test Each Electric-Drive Controller:

1) Verify that voltages at controller locations are within 1 percent of motor nameplate rated voltages, with motors off. If outside this range for motor, notify [**Architect**][**Construction Manager**][**Owner**] before starting the motor(s).
2) Test each motor for proper phase rotation.

3) Verify short-circuit current rating.

c. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2. Acceptance tests and inspections must be witnessed by [**Architect**][**Construction Manager**][**Owner**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.
3. Acceptance Tests and Inspections:

a. Do not begin field-acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to [**Architect**][**Construction Manager**][**Owner**] and authorities having jurisdiction.
b. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
c. Engage manufacturer's factory-authorized service representative to be present during the testing.
d. Perform field-acceptance tests as outlined in NFPA 20.

4. Nonconforming Work:

a. Controllers will be considered defective if they do not pass tests and inspections.
b. Remove and replace defective units with new units and retest.

5. Prepare and submit field-acceptance testing and inspection reports.

3.6 STARTUP SERVICE FOR PRESSURE-MAINTENANCE PUMPS AND CONTROLLERS

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. <**Insert startup steps**>.

3.7 ADJUSTING

A. Adjust pressure-maintenance-pump controllers to function smoothly and as recommended by manufacturer.

B. Set field-adjustable pressure switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recordings, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Lubricate pumps as recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

A. Test each pressure-maintenance pump with its controller as a unit.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
2. Test in accordance with NFPA 20 for acceptance and performance testing.
    a. Prior to initial startup and acceptance testing, complete and check all electric wiring serving pressure-maintenance pump motor and interwiring, normal power, and alternate power.
    b. Perform arc flash risk assessment for all electric pressure-maintenance pump controllers in accordance with NFPA 70E or other code required by authorities having jurisdiction.
    c. Field label electric pressure-maintenance pump controllers for arc flash risk in accordance with NFPA 70E or other code required by authorities having jurisdiction.
3. Leak Test: After installation, fill system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 26 29 33 13A

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SECTION 26 31 00 00 - PHOTOVOLTAIC COLLECTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured PV units.
2. PV module framing.
3. PV array construction.
4. Inverters.
5. System overcurrent protection.
6. Mounting structures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. CEC: California Energy Commission.

B. ETFE: Ethylene tetrafluoroethylene.

C. FEP: Fluorinated ethylene propylene.

D. IP Code: Required ingress protection to comply with IEC 60529.

E. MPPT: Maximum power point tracking.

F. PTC: PVUSA Test Condition. Commonly regarded as a "real-world" measure of PV output. See below for definition of "PVUSA."

G. PV: Photovoltaic.

H. PVUSA: Photovoltaics for Utility Systems Applications.

I. STC: Standard Test Conditions defined in IEC 61215.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Manufactured PV units.
2. PV module framing.

3. PV array construction.
4. Inverters.
5. System overcurrent protection.
6. Mounting structures.

B. Shop Drawings: For PV modules.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly.
4. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.

1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:

a. Faulty operation of PV modules.
b. <**Insert failure modes**>.

2. Warranty Period: [**Two**][**Five**]<**Insert number**> years from date of Substantial Completion.

B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.

1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:

a. Specified minimum power output to [**80**]<**Insert number**> percent or more, for a period of [**25**]<**Insert number**> years.

b. <**Insert additional minimum power output special warranty**>.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aleo Solar**]
2. [**BP Solar USA**]
3. [**Canadian Solar**]
4. [**ET Solar**]
5. [**Evergreen Solar, Inc.**]
6. [**GE Solar; General Electric Company**]
7. [**Kaneka Corporation**]
8. [**Kyocera International, Inc.**]
9. [**Lumos Solar, LLC**]
10. [**Mitsubishi Electric US, Inc.**]
11. [**REC Solar US LLC**]
12. [**SANYO North America Corporation**]
13. [**Schott Solar**]
14. [**Sharp Electronics Corp.**]
15. [**Suniva**]
16. [**SunPower Corporation**]
17. [**Suntech Power**]
18. [**Trina Solar Limited**]
19. [**United Solar Ovonic LLC**]
20. [**Yingli Green Energy Holding Co., Ltd.**]
21. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aleo Solar**]
2. [**BP Solar USA**]
3. [**Canadian Solar**]
4. [**ET Solar**]
5. [**Evergreen Solar, Inc.**]
6. [**GE Solar; General Electric Company**]
7. [**Kaneka Corporation**]
8. [**Kyocera International, Inc.**]
9. [**Lumos Solar, LLC**]
10. [**Mitsubishi Electric US, Inc.**]
11. [**REC Solar US LLC**]
12. [**SANYO North America Corporation**]
13. [**Schott Solar**]
14. [**Sharp Electronics Corp.**]
15. [**Suniva**]
16. [**SunPower Corporation**]
17. [**Suntech Power**]
18. [**Trina Solar Limited**]
19. [**United Solar Ovonic LLC**]

20. [**Yingli Green Energy Holding Co., Ltd.**]
21. <**Insert manufacturer's name**>

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Hazardous Locations: FM Global approved for NFPA 70, Class 1, Division 2, Group C and Group D.

2.3 PV CAPACITIES AND CHARACTERISTICS

A. Minimum Electrical Characteristics:

1. Rated Open-Circuit Voltage: <**Insert V(dc)**>.
2. Maximum System Voltage: <**Insert V(dc)**>.
3. Maximum Power at Voltage (Vpm): <**Insert V(dc)**>.
4. Short-Circuit Temperature Coefficient: <**Insert mA/deg C**>.
5. Rated Short-Circuit Current (Isc): <**Insert amperes**>.
6. Maximum System: <**Insert V(dc)**>.
7. Rated Operation Current (Imp): <**Insert amperes**>.
8. Maximum Power at STC (Pmax): <**Insert watts**>.

B. Additional Electrical Characteristics:

1. PTC Rating: <**Insert watts**>.
2. Peak Power per Unit Area: <**Insert watts**>.
3. Tolerance of Pmax: <**Insert number**> percent.
4. Minimum Peak Power: <**Insert watts**>.
5. Series Fuse Rating: <**Insert amperes**>.
6. Module Efficiency: <**Insert number**> percent.
7. Temperature Cycling Range: <**Insert deg C**>.
8. Humidity, Freeze, Damp Heat Condition: <**Insert number**> percent RH.
9. Wind Loading or Surface Pressure: <**Insert lb/ft2 (N/m2)**>.
10. Maximum Distortion Angle: <**Insert degrees**>.
11. Hailstone Impact Withstand: <**Insert inch (mm)**> diameter at <**Insert mile/h (km/h)**> wind velocity.

C. Normal Operating Temperature Characteristics (NOTC):

1. Temperature at Nominal Operating Cell Temperature: <**Insert deg C**>.
2. Temperature Coefficient (NOTC Nominal Power): <**Insert deg C**>.
3. Temperature Coefficient (NOTC Open-Circuit Voltage): <**Insert deg C**>.
4. Temperature Coefficient (NOTC Short Circuit Current): <**Insert deg C**>.
5. Temperature Coefficient (NOTC Maximum Power Voltage): <**Insert deg C**>.
6. Temperature Coefficient (NOTC Maximum Power Current): <**Insert deg C**>.

2.4 PV SYSTEMS DESCRIPTION

A. Interactive PV System: Collectors connected in parallel to the electrical utility; and capable of providing power for Project and supplying power to a distributed network.

1. A [**six**]<**Insert number**>-module array to generate a total nominal rated output of [**1000 W**]<**Insert watts**>.
2. System Components:

    a. PV modules.
    b. Array frame.
    c. Utility-interactive inverter.
    d. Overcurrent protection, disconnect, and rapid shutdown devices.
    e. Mounting structure.
    f. Utility meter.
    g. <**Insert component**>.

B. Hybrid PV System: Collectors connected to provide power to DC and AC loads, connected to utility through interactive inverters or meters, and connected to energy storage.

1. A [**six**]<**Insert number**>-module array to generate a total nominal rated output of [**1000 W**]<**Insert watts**>.
2. System Components:

    a. PV modules.
    b. Array frame.
    c. Charge controller.
    d. Energy storage.
    e. System control.
    f. [**Inverter**][**Utility-interactive inverter**].
    g. Overcurrent protection, disconnect, and rapid shutdown devices.
    h. Mounting structure.
    i. [**Meter**][**Utility-interactive meter**].
    j. <**Insert component**>.

C. Stand-Alone PV System: Collectors connected to provide power to Project DC and AC loads through an energy storage system.

1. A [**six**]<**Insert number**>-module array to generate a total nominal rated output of [**1000 W**]<**Insert watts**>.
2. System Components:

    a. PV modules.
    b. Array frame.
    c. Charge controller.
    d. Energy storage.
    e. Inverter.
    f. Overcurrent protection, disconnect, and rapid shutdown devices.
    g. Mounting structure.

2.5 MANUFACTURED PV UNITS

A. Cell Materials, Thin Film:

1. Amorphous silicon (a-Si).
2. Micromorphous silicon (a-Si+uc-Si).
3. Copper indium (di)selenide (CIS).
4. Copper indium gallium (di)selenide (CIGS).
5. Cadmium telluride (CdTe).
6. Cadmium sulfide.

B. Cell Materials, Wafer: [**Polycrystalline**][**Monocrystalline**].

1. c-Si.
2. Gallium arsenide (GaAs).

C. Module Construction:

1. Nominal Size: **32 inch (800 mm)** wide by **64 inch (1600 mm)** long.
2. Weight: **42.8 lb (19.4 kg)**.

D. Insulating Substrate Film: [**Flexible**][**Rigid**], [**polyester**][**polyimide**].

E. Conducting Substrate Film: [**Flexible**][**Rigid**][**Fluoropolymer**], [**ETFE**][**FEP**].

F. Encapsulant: Ethyl vinyl acetate.

G. Front Panel: [**Fully tempered glass**][**0.125 inch (3.2 mm) thick glass**][**Low iron glass**][**Antireflective coating glass**][**Laminating film**][**Laminating material**].

H. Backing Material: [**Tempered glass**][**0.125 inch (3.2 mm) thick glass**][**Polyester film**][**PVC film**].

1. Layers: <**Insert number**>.
2. Color: [**White**]<**Insert color**>.

I. Bypass Diode Protection: Internal.

J. Junction Box:

1. Size: **1.56-by-3.96-by-0.52 inch (39.6-by-100.6-by-13.2 mm)**.
2. Fully potted, vandal resistant.
3. IP Code: [**IP65**][**IP66**][**IP67**]<**Insert IP code designation**>.
4. Flammability Test: UL 1703.

K. Output Cabling:

1. [**0.158 inch (4 mm)**]<**Insert dimension**>.
2. Quick, multiconnect, polarized connectors.
3. Two-Conductor Harness: No traditional return wire is needed from the end of a row back to the source combiner.

L. Series Fuse Rating: <**Insert amperes**>.

2.6 PV MODULE FRAMING

A. PV laminates mounted in anodized extruded-aluminum frames.

1. Entire assembly UL listed for electrical and fire safety, [**Class A**][**Class C**], according to UL 1703, and complying with IEC 61215.
2. Frame strength exceeding requirements of certifying agencies in subparagraph above.
3. Anodized Aluminum Finish: Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish.
4. High-performance Organic Finish: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not

less than 70 percent PVC resin by weight.
5. Baked-enamel finish.
6. Color: As indicated by manufacturer's designations.

2.7 PV ARRAY CONSTRUCTION

A. Framing:

1. Material: [**Extruded aluminum**][**Galvanized steel**][**Coated steel**].
2. Maximum System Weight: Less than **4 lb/ft2 (19.53 kg/m2)**.
3. Minimum Distance to Connectors: <**Insert inch (mm)**>.
4. Raceway Cover Plates: [**Plastic**][**Aluminum**][**Galvanized steel**].

B. Flat-Roof Mounting:

1. No roof penetrations.
2. Self-ballasting.
3. Wind-tunnel tested to **110 mile/h (160 km/h)** wind.
4. Service Life: [**25**]<**Insert number**> years.
5. Freestanding system.

2.8 INVERTER

A. Inverter Type: [**Central**][**Microgrid**].

B. Control Type: [**Pulse-width-modulation control**][**Maximum power point tracker control**].

C. Inverter Electrical Characteristics:

1. Maximum Recommended PV Input Power: <**Insert kilowatts**>.
2. Maximum Open-Circuit Voltage: <**Insert V(dc)**>.
3. PV Start Voltage: <**Insert V(dc)**>.
4. MPPT Voltage Range: <**Insert V(dc)**>.
5. Maximum Input Current: <**Insert amperes**>.
6. Number of String Inputs: <**Insert number**>.
7. Number of Independent MPPT Circuits: <**Insert value**>.
8. Nominal Output Voltage: <**Insert V(dc)**>.
9. CEC Rated Power: <**Insert kilowatts**>.
10. Maximum Output Current: <**Insert amperes**>.
11. Peak Efficiency: <**Insert number**> percent.
12. CEC Weighted Efficiency: <**Insert number**> percent.
13. CEC Night Tare Loss: <**Insert watts**>.
14. DC/AC Terminal Range (AWG): <**Insert range of AWG values**>.
15. Communications Interface: [**TIA-485**][**TIA-232**][**Ethernet**][**Zigbee**]<**Insert type**>.
16. Utility Interface: Utility-interactive inverter.

D. Operating Conditions:

1. Operating Ambient Temperatures: **Minus 4 to plus 122 deg F (20 to plus 50 deg C)**.
2. Storage Temperature: **Minus 40 to plus 122 deg F (minus 40 to plus 50 deg C)**.
3. Relative Humidity: Zero to 95 percent, noncondensing.

E. Charge controllers must have the following:

1. Overcurrent protection.
2. Generator input breaker box.
3. Automatic transfer relay.
4. Digital display.
5. Transformer.
6. Disconnect switch.
7. Shunt controller.
8. Shunt regulator.
9. Surge overload protection.

F. Enclosure:

1. UL 50E[**, Type 3R**][**, Type 4X**].
2. Enclosure Material: [**Galvanized steel**][**Steel**].
3. Cooling Methods:

   a. Fan convection cooling.
   b. Passive cooling.

4. Protective Functions:

   a. AC over/undervoltage.
   b. AC over/underfrequency.
   c. Ground overcurrent.
   d. Overtemperature.
   e. AC and DC overcurrent.
   f. DC overvoltage.

5. Standard LCD, four lines, 20 characters, with user display and on/off toggle switch.

G. Disconnects: Rated for system voltage and conductor.

H. Regulatory Approvals:

1. IEEE 1547.1.
2. IEEE 1547.3.
3. UL 1741.

I. Characteristics:

1. Inverter Dimensions: <**Insert inch (mm)**>.
2. Inverter Weight: <**Insert lb (kg)**>.

2.9 SYSTEM OVERCURRENT PROTECTION

A. Fuses: <**Insert amperes**>.

B. Circuit Breakers: <**Insert amperes**>.

2.10 MOUNTING STRUCTURES

A. Roof Mount: Extruded aluminum, [**two**][**four**] rails, tilt legs, and roof standoffs.

B. Pole Mount: [**Top**][**Panel tops**][**Side**].

C. Tracking Mounts: [**One**][**Two**] axis.

2.11 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Do not begin installation until mounting surfaces have been properly prepared.

C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.

E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of PV panels with [**roof**][**support**] assembly and other construction.

B. Support PV panel assemblies independent of supports for other elements such as roof and support assemblies, enclosures, vents, pipes, and conduits. Support assembly to prevent twisting from eccentric loading.

C. Install PV [**inverters,**][**energy storage,**][**charge controller,**][**rapid shutdown,**][**and**][**system control**] in locations indicated on Drawings.

D. Install weatherseal fittings and flanges where PV panel assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Section 079200 "Joint Sealants" for materials and application.

E. Seismic Restraints: Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electric Systems."

F. Wiring Method: Install cables in raceways.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

A. Coordinate PV panel cabling to equipment enclosures to ensure proper connections.

B. Coordinate installation of utility-interactive meter with utility.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Make splices, terminations, and taps that are compatible with conductor material[**and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors**].

END OF SECTION 26 31 00 00

Task	Specification	Specification Description
26 31 00 00	26 01 00 00	Supplemental Requirements for Electrical
26 32 13 00	26 32 13 19	Bi-Fuel-Engine-Driven Generator Sets

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SECTION 26 32 13 13 - DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diesel-engine-driven generator sets.
2. Diesel engine.
3. Diesel fuel-oil system.
4. Control and monitoring.
5. Generator overcurrent and fault protection.
6. Generator, exciter, and voltage regulator.
7. Load bank.
8. Outdoor engine generator enclosure.
9. Remote radiator motors.
10. Vibration isolation devices.

B. Related Requirements:

1. Section 262313 "Paralleling Low-Voltage Switchgear" for controls and paralleling equipment for large or multiple parallel engine generators.
2. Section 263343 "Battery Chargers" for remote engine battery chargers.
3. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in **gallons per hour (liters per hour)** at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in **cubic feet per minute (cubic meters per minute)** at 0.8 power factor, with air-supply temperature of **95, 80, 70, and 50 deg F (35, 27, 21, and 10 deg C)**. Provide Drawings indicating requirements and limitations for location

of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**and**][**testing agency**].

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight[**, including full fuel tank**], [**supplied enclosure,**][**external silencer,**][**subbase-mounted fuel tank,**][**skid-mounted load bank,**] and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIESEL-ENGINE-DRIVEN GENERATOR SETS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Caterpillar, Inc.; Electric Power Division**]
2. [**Cummins Power Generation**]
3. [**Generac**]

4. [**Hipower Systems**]
5. [**Kohler Power Systems**]
6. [**Rolls-Royce Solutions America Inc.**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Caterpillar, Inc.; Electric Power Division**]
2. [**Cummins Power Generation**]
3. [**Generac**]
4. [**Hipower Systems**]
5. [**Kohler Power Systems**]
6. [**Rolls-Royce Solutions America Inc.**]
7. <**Insert manufacturer's name**>

C. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, [**subbase fuel tank,**][**day tank,**] engine generator, batteries, battery racks, silencers, [**load banks,**] sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.[**Water shall be substituted for diesel fuel in fuel tank during test.**]
3. Component Importance Factor: [**1.5**][**1.0**].

B. B11 Compliance: Comply with B11.19.

C. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level [**1**][**2**] EPSS.

D. UL Compliance: Comply with UL 2200.

E. Engine Exhaust Emissions: Comply with EPA Tier [**2**][**3**][**4**] requirements and applicable state and local government requirements.

F. Noise Emission: Comply with [**applicable state and local government requirements**]<**Insert Project criteria**> for maximum noise level at [**adjacent property boundaries**]<**Insert critical locations**> due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: [41 to 104 deg F (5 to 40 deg C)][5 to 104 deg F (Minus 15 to plus 40 deg C)].
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to [1000 feet (300 m)]<**Insert altitude**>.

H. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:

1. [**High salt-dust content in the air due to sea-spray evaporation**]<**Insert unusual condition**>.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Power Rating: [**Prime**][**Industrial**][**Standby**].

D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

E. EPSS Class: Engine generator shall be classified as a [**Class 2**][**Class 6**][**Class 48**][**Class 96**]<**Insert classification**> according to NFPA 110.

F. Service Load: <**Insert number**> kVA.

G. Power Factor: [**0.8**]<**Insert number**>, lagging.

H. Frequency: 60 Hz.

I. Voltage: [**208**][**240**][**480**][**600**][**4160**]-V ac.

J. Phase: Three-phase, [**three**][**four**] wire, [**wye**][**delta**].

K. Induction Method: [**Naturally aspirated**][**Turbocharged**].

L. Governor: Adjustable isochronous, with speed sensing.

M. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

N. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries[**, with capacity as required to operate as a unit as evidenced by records of prototype testing**].
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

O. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time:

    a. Comply with NFPA 110, [**Type U**][**Type 10**] system requirements.
    b. [**10**]<**Insert number**> seconds.

P. Engine Generator Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

    a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time:

a. Comply with NFPA 110, [**Type U**][**Type 10**] system requirements.
b. [**10**]<**Insert number**> seconds.

Q. Parallel Engine Generators:

1. Automatic reactive output power control and load sharing between engine generators operated in parallel.
2. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.
3. Protective relays required for equipment and personnel safety.
4. Paralleling suppressors to protect excitation systems.
5. Reverse power protection.
6. Loss of field protection.

2.4 DIESEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.

1. <**Insert specific fuel grade requirements**>.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499[**and with NFPA 110 requirements for Level 1 equipment for heater capacity**].

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

a. Rating: **50-psig (345-kPa)** maximum working pressure with coolant at **180 deg F (82 deg C)**, and noncollapsible under vacuum.

b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Remote Cooling System: Closed loop, liquid cooled, with remote radiator and [**integral engine driven**][**auxiliary**] coolant pump. Comply with requirements in Section 232113 "Hydronic Piping" for coolant piping.

1. Configuration: [**Vertical**][**Horizontal**] air discharge.
2. Radiator Core Tubes: [**Aluminum**][**Nonferrous-metal construction other than aluminum**].
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Fan: Driven by [**multiple belts from engine shaft**][**totally enclosed electric motor with sealed bearings**].
6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

G. Muffler/Silencer:

1. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

   a. Minimum sound attenuation of 25 dB at 500 Hz.
   b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**78**]<**Insert number**> dBA or less.

2. Semicritical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

   a. Minimum sound attenuation of 18 dB at 500 Hz.
   b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**85**]<**Insert number**> dBA or less.

3. Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

   a. Minimum sound attenuation of 12 dB at 500 Hz.
   b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**90**]<**Insert number**> dBA or less.

H. Air-Intake Filter: [**Standard**][**Heavy**]-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: [**12**][**24**]-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: [**As required by NFPA 110 for system level specified**][**60 seconds**].
4. Battery: [**Lead acid**][**Nickel cadmium**], with capacity within ambient temperature range specified

in "Performance Requirements" Article to provide specified cranking cycle at least [**twice**][**three times**] without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above **50 deg F (10 deg C)** regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for [**lead-acid**][**nickel-cadmium**] batteries. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from **minus 40 to 140 deg F (minus 40 to plus 60 deg C)** to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Fuel-Oil Storage Tank: Comply with requirements in [**Section 231313 "Facility Underground Fuel-Oil Storage Tanks."**][**Section 231323 "Facility Aboveground Fuel-Oil Storage Tanks."**]

1. Fuel Tank Capacity: [**Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills plus fuel for the hours of continuous operation required for the indicated EPSS Class.**][**As recommended by engine manufacturer for an uninterrupted period of 8 hours' operation at 100 percent of rated power output of engine generator**

system without being refilled]<**Insert gallons (liters)**>.

2. Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 231213 "Facility Fuel-Oil Pumps."

G. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

   a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: [**As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine generator system without being refilled**]<**Insert gallons (liters)**>.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor-control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.

H. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

1. Tank level indicator.
2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for planned operation plus fuel for periodic maintenance operations between fuel refills.
3. Leak detection in interstitial space.
4. Vandal-resistant fill cap.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for [**15**][**30**]<**Insert number**> minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.
3. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:

    a. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.
    b. Switchboard Construction: Freestanding unit complying with Section 262413 "Switchboards." Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
    c. Switchgear Construction: Freestanding unit complying with Section 262300 "Low-Voltage Switchgear."

F. Control and Monitoring Panel:

1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3. Instruments: Located on the control and monitoring panel and viewable during operation.

    a. Engine lubricating-oil pressure gage.
    b. Engine-coolant temperature gage.
    c. DC voltmeter (alternator battery charging).
    d. Running-time meter.
    e. AC voltmeter, [**for each phase**][**connected to a phase selector switch**].
    f. AC ammeter, [**for each phase**][**connected to a phase selector switch**].
    g. AC frequency meter.
    h. Generator-voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

    a. Cranking control equipment.
    b. Run-Off-Auto switch.
    c. Control switch not in automatic position alarm.
    d. Overcrank alarm.
    e. Overcrank shutdown device.
    f. Low-water temperature alarm.
    g. High engine temperature prealarm.
    h. High engine temperature.

i. High engine temperature shutdown device.
j. Overspeed alarm.
k. Overspeed shutdown device.
l. Low fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required [**for the indicated EPSS class**][**in "Fuel Tank Capacity" Subparagraph in "Diesel Fuel-Oil System" Article**].

m. Coolant low-level alarm.
n. Coolant low-level shutdown device.
o. Coolant high-temperature prealarm.
p. Coolant high-temperature alarm.
q. Coolant low-temperature alarm.
r. Coolant high-temperature shutdown device.
s. EPS load indicator.
t. Battery high-voltage alarm.
u. Low cranking voltage alarm.
v. Battery-charger malfunction alarm.
w. Battery low-voltage alarm.
x. Lamp test.
y. Contacts for local and remote common alarm.
z. Low-starting air pressure alarm.
aa. Low-starting hydraulic pressure alarm.
bb. Remote manual stop shutdown device.
cc. Air shutdown damper alarm when used.
dd. Air shutdown damper shutdown device when used.
ee. Generator overcurrent-protective-device not-closed alarm.
ff. Hours of operation.
gg. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

G. Engine Generator Metering: Comply with [**Section 260913 "Electrical Power Monitoring and Control."**][**Section 262713 "Electricity Metering."**][**Section 260913 "Electrical Power Monitoring and Control" and Section 262713 "Electricity Metering."**]

H. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via [**ModBus**][**LonWorks**][**Ethernet**]<**Insert data protocol**>. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

I. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

J. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Low water-temperature alarm.

3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.
19. Generator overcurrent-protective-device not-closed alarm.

K. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

L. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Molded-case circuit breaker, thermal-magnetic type; 100 percent rated; complying with UL 489:

    a. Tripping Characteristic: Designed specifically for generator protection.
    b. Trip Rating: Matched to generator output rating.
    c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
    d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

2. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

    a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
    b. Trip Settings: Selected to coordinate with generator thermal damage curve.
    c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
    d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

3. Insulated-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

4. Molded-case type disconnect switch; 100 percent rated:

a. Trip Rating: Matched to generator output rating.
b. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.
2. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: [**Class H**][**or**][**Class F**].

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide [**six**][**12**]-lead alternator.

E. Range: Provide [**limited**][**broad**][**extended**] range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified[**and as required by NFPA 110**].

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within [**15**][**20**][**30**] percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within [**5**][**10**][**15**] percent and stabilize at rated frequency within [**2**][**5**] seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: [**12**]<**Insert number**> percent, maximum.

2.9 LOAD BANK

A. Description:

1. Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, [**resistive**][**resistive and reactive**] unit capable of providing a balanced three-phase, delta-connected load to engine generator at [**100**]<**Insert number**> percent rated-system capacity, at [**80**]<**Insert number**> percent power factor, lagging.[**Unit may contain separate resistive and reactive load banks controlled by a common control panel.**] Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.
2. Permanent, radiator-mounted[**, resistive**] unit capable of providing a balanced three-phase, delta-connected load to engine generator at [**50**][**70**]<**Insert number**> percent rated-system capacity. Unit shall be capable of selective control of load in 25 percent steps of load-bank rating and with minimum step changes of approximately 5 and 10 percent available.

B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and stainless-steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases. Galvanized steel is prohibited. Element's maximum resistance shall be between 100 and 105 percent of rated resistance.

C. Reactive Load Elements: Epoxy-encapsulated reactor coils.

D. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

E. Load-Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

F. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

G. Load-Bank Enclosures: NEMA 250, Type 3R, aluminized steel complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with **1/2-inch- (13-mm-)** square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge. Components other than resistive elements shall

receive exterior epoxy coating with compatible primer. Comply with requirements in Section 099600 "High-Performance Coatings."

H. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.

I. Load-Bank Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

J. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.10 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description:

1. Vandal-resistant, sound-attenuating, weatherproof steel housing; wind resistant up to **100 mph (160 km/h)**. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

    a. Sound Attenuation Level: <**Insert level**>.

2. Prefabricated or pre-engineered, galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure; erected on concrete foundation.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to **100 mph (160 km/h)**.

C. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Fire Protection: Provide fire protection according to Section 211000 "Water-Based Fire-Suppression Systems." Provide smoke detector in enclosure; mounted according to NFPA 72.

E. Hinged Doors: With padlocking provisions.

F. Space Heater: Thermostatically controlled and sized to prevent condensation.

G. Lighting: Provide weather-resistant [**fluorescent**][**LED**] lighting with [**30 fc (330 lx)**][**50 fc (550 lx)**] average maintained.

H. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

I. Muffler Location: [**Within**][**External to**] enclosure.

J. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature

at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

K. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

L. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

2.11 REMOTE RADIATOR MOTORS

A. Description: NEMA MG 1, Design B, medium-induction, random-wound, squirrel-cage motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Temperature Rise: Match insulation rating.

G. Code Letter Designation:

1. Motors [**15**]<**Insert number**> HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than [**15**]<**Insert number**> HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.12 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: [**Standard neoprene**][**Natural rubber**][**Bridge-bearing neoprene, complying with AASHTO M 251**] separated by steel shims.
2. Shore A Scale Durometer Rating: [**30**][**40**][**45**][**50**][**60**][**65**][**70**]<**Insert number**>.

3. Number of Layers: [**One**][**Two**][**Three**][**Four**]<**Insert number**>.
4. Minimum Deflection: [**1 inch (25 mm)**]<**Insert value**>.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to **1/4-inch- (6-mm-)** thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: [**1 inch (25 mm)**]<**Insert value**>.

C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.13 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.14 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with IEEE 115[**and with NFPA 110, Level 1 Energy Converters**].

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions[**and with NFPA 110**].

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators[**and remote radiators mounted on grade**]. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install [**packaged engine generator**][**engine generator in a walk-in enclosure**] with [**elastomeric isolator pads**][**restrained spring isolators**] having a minimum deflection of [**1 inch (25 mm)**]<**Insert static deflection**> on **4-inch- (100-mm-)** high concrete base. Secure [**sets**][**enclosure**] to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Remote Radiators:

a. Install remote radiator with [**elastomeric isolator pads**][**restrained spring isolators**] on [**concrete base on grade**][**roof equipment supports on roof**].
b. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Section 077200 "Roof Accessories."

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Cooling System: Install Schedule 40 black steel piping with welded joints for cooling water piping between engine generator and [**heat exchanger**][**remote radiator**]. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."

1. Install isolating thimbles where exhaust piping penetrates combustible surfaces. Provide a minimum of **9 inches (225 mm)** of clearance from combustibles.
2. Insulate cooling-system piping and components according to requirements in Section 230719 "HVAC Piping Insulation."

F. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
3. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
4. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of **9 inches (225 mm)** of clearance from combustibles.

G. Drain Piping: Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Drain piping valves, connectors, and installation requirements are specified in Section 232116 "Hydronic Piping Specialties."

H. Fuel Piping:

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."
2. Copper and galvanized steel shall not be used in the fuel-oil piping system.

I. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

C. Connect cooling-system water piping to engine generator and [**remote radiator**][**heat exchanger**] with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.
3. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
4. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

    a. Visual and Mechanical Inspection:

        1) Compare equipment nameplate data with Drawings and the Specifications.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, and grounding.
        4) Verify that the unit is clean.

    b. Electrical and Mechanical Tests:

        1) Perform insulation-resistance tests according to IEEE 43.

            a) Machines Larger Than **200 hp (150 kW)**: Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines **200 hp (150 kW)** or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

        2) Test protective relay devices.
        3) Verify phase rotation, phasing, and synchronized operation as required by the application.
        4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
        5) Perform vibration test for each main bearing cap.
        6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding **40-inch wg (120 kPa)**. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at [**four**]<**Insert number**> locations [**25 feet (8 m) from edge of the generator enclosure**][**on the property line**]<**Insert location for measurement**>, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and [**retest**][**reinspect**] as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**12**]<**Insert number**> months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 32 13 13

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Task	Specification	Specification Description
26 32 13 13	26 32 13 19	Bi-Fuel-Engine-Driven Generator Sets

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SECTION 26 32 13 19 - BI-FUEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bi-fuel-engine-driven generator sets.
2. Bi-fuel engine.
3. Diesel fuel-oil system.
4. Gas fuel system.
5. Control and monitoring.
6. Generator overcurrent and fault protection.
7. Generator, exciter, and voltage regulator.
8. Load bank.
9. Outdoor engine generator enclosure.
10. Remote radiator motors.
11. Vibration isolation devices.

B. Related Requirements:

1. Section 262313 "Paralleling Low-Voltage Switchgear" for controls and paralleling equipment for large or multiple parallel engine generators.
2. Section 263343 "Battery Chargers" for remote engine battery chargers.
3. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 DEFINITIONS

A. Bi-Fuel: An engine generator that starts using diesel fuel, and upon assumption of the electrical load, transitions to a diesel fuel and natural gas mix.

B. EPS: Emergency power supply.

C. EPSS: Emergency power supply system.

D. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in [**gallons per hour (liters per hour)**][**and**][**cubic feet per hour (cubic meters per hour)**] at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

a. Include fuel consumption at power factor and loads above at 3:1, 2:1, and 1:1 natural gas to diesel ratio.

5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in **cubic feet per minute (cubic meters per minute)** at 0.8 power factor, with air-supply temperature of **95, 80, 70, and 50 deg F (35, 27, 21, and 10 deg C)**. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**manufacturer**][**and**][**testing agency**].

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight[**including full fuel tank**], [**supplied enclosure,**][**external silencer,**][**subbase-mounted fuel tank,**][**skid-mounted load bank,**] and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.

6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BI-FUEL-ENGINE-DRIVEN GENERATOR SETS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Caterpillar, Inc.; Electric Power Division**]
2. [**Cummins Power Generation**]
3. [**Generac**]
4. [**Rolls-Royce Solutions America Inc.**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Caterpillar, Inc.; Electric Power Division**]
2. [**Cummins Power Generation**]
3. [**Generac**]
4. [**Rolls-Royce Solutions America Inc.**]
5. <**Insert manufacturer's name**>

C. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, [**subbase fuel tank,**][**day tank,**] engine generator, batteries, battery racks, silencers, [**load banks,**]and sound-attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst case normal levels.[**Water shall be substituted for diesel fuel in fuel tank during test.**]
3. Component Importance Factor: [**1.5**][**1.0**].

B. B11 Compliance: Comply with B11.19.

C. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level [**1**][**2**] EPSS.

D. UL Compliance: Comply with UL 2200.

E. Engine Exhaust Emissions: Comply with EPA Tier [**2**][**3**][**4**] requirements and applicable state and local

government requirements.

F. Noise Emission: Comply with [**applicable state and local government requirements**]<**Insert Project criteria**> for maximum noise level at [**adjacent property boundaries**]<**Insert critical locations**> due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: [**41 to 104 deg F (5 to 40 deg C)**][**5 to 104 deg F (Minus 15 to plus 40 deg C)**].
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to [**1000 feet (300 m)**]<**Insert altitude**>.

H. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:

1. [**High salt-dust content in the air due to sea-spray evaporation**]<**Insert unusual condition**>.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.

C. Power Rating: [**Prime**][**Industrial**][**Standby**].

D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

E. EPSS Class: Engine generator shall be classified as a [**Class 2**][**Class 6**][**Class 48**][**Class 96**]<**Insert classification**> according to NFPA 110.

F. Service Load: <**Insert number**> kVA.

G. Power Factor: [**0.8**]<**Insert number**>, lagging.

H. Frequency: 60 Hz.

I. Voltage: [**208**][**240**][**480**][**600**][**4160**]-V ac.

J. Phase: Three-phase, [**three**][**four**]-wire, [**wye**][**delta**].

K. Induction Method: [**Naturally aspirated**][**Turbocharged**].

L. Governor: Adjustable isochronous, with speed sensing.

M. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

N. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries[**, with capacity as required to operate as a unit as evidenced by records of prototype testing**].
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

O. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time:

    a. Comply with NFPA 110, [**Type U**][**Type 10**] system requirements.
    b. [**10**]<**Insert number**> seconds.

P. Engine Generator Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

    a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three

seconds.

7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

    a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time:

    a. Comply with NFPA 110, [**Type U**][**Type 10**] system requirements.
    b. [**10**]<**Insert number**> seconds.

Q. Parallel Engine Generators:

1. Automatic reactive output power control and load sharing between engine generators operated in parallel.
2. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.
3. Protective relays required for equipment and personnel safety.
4. Paralleling suppressors to protect excitation systems.
5. Reverse power protection.
6. Loss of field protection.

2.4 BI-FUEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15 and natural gas.

1. <**Insert specific fuel grade requirements**>.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skidmounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499[**and with NFPA 110 requirements for Level 1 equipment for heater capacity**].

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110

percent load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: **50-psig (345-kPa)** maximum working pressure with coolant at **180 deg F (82 deg C)**, and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Remote Cooling System: Closed loop, liquid cooled, with remote radiator and [**integral engine-driven**][**auxiliary**] coolant pump. Comply with requirements in Section 232113 "Hydronic Piping" for coolant piping.

1. Configuration: [**Vertical**][**Horizontal**] air discharge.
2. Radiator Core Tubes: [**Aluminum**][**Nonferrous-metal construction other than aluminum**].
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Fan: Driven by [**multiple belts from engine shaft**][**totally enclosed electric motor with sealed bearings**].
6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

G. Muffler/Silencer:

1. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 25 dB at 500 Hz.
    b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**78**]<**Insert number**>dBA or less.

2. Semicritical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 18 dB at 500 Hz.
    b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**85**]<**Insert number**>dBA or less.

3. Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 12 dB at 500 Hz.
    b. Sound level measured at a distance of **25 feet (8 m)** from exhaust discharge after installation is complete shall be [**90**]<**Insert number**>dBA or less.

H. Air-Intake Filter: [**Standard**][**Heavy**]-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: [**12**][**24**]-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: [**As required by NFPA 110 for system level specified**][**60 seconds**].
4. Battery: [**Lead acid**][**Nickel cadmium**], with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least [**twice**][**three times**] without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above **50 deg F (10 deg C)** regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for [**lead-acid**][**nickel-cadmium**] batteries. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from **minus 40 to 140 deg F (minus 40 to plus 60 deg C)** to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Fuel-Oil Storage Tank: Comply with requirements in [**Section 231313 "Facility Underground Fuel-Oil Storage Tanks."**][**Section 231323 "Facility Aboveground Fuel-Oil Storage Tanks."**]

1. Fuel Tank Capacity: [**Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills plus fuel for the hours of continuous operation required for the indicated EPSS Class.**][**As recommended by engine manufacturer for an uninterrupted period of 8 hours' operation at 100 percent of rated power output of engine generator system without being refilled**]<**Insert gallons (liters)**>.
2. Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 231213 "Facility Fuel-Oil Pumps."

G. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

    a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: [**As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine generator system without being refilled**]<**Insert gallons (liters)**>.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor-control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.

H. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

1. Tank level indicator.
2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills, plus fuel for the hours of continuous operation for indicated EPSS class.
3. Leak detection in interstitial space.
4. Vandal-resistant fill cap.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 GAS FUEL SYSTEM

A. Natural Gas Piping: Comply with requirements in Section 231123 "Facility Natural Gas Piping."

B. Gas Train: Comply with NFPA 37.

C. Engine Fuel System:

1. Natural Gas, Vapor-Withdrawal System:

a. Carburetor.
b. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
c. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
d. Fuel Filters: One for each fuel type.
e. Manual Fuel Shutoff Valves: One for each fuel type.
f. Flexible Fuel Connectors: Minimum one for each fuel connection.

2.7 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run-time control set for [**15**][**30**]<**Insert number**> minutes with override only by operating a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.
3. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:

a. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.

b. Switchboard Construction: Freestanding unit complying with Section 262413 "Switchboards." Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
c. Switchgear Construction: Freestanding unit complying with Section 262300 "Low-Voltage Switchgear."

F. Control and Monitoring Panel:

1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3. Instruments: Located on the control and monitoring panel and viewable during operation.

a. Engine lubricating-oil pressure gage.
b. Engine-coolant temperature gage.
c. DC voltmeter (alternator battery charging).
d. Running-time meter.
e. AC voltmeter, [**for each phase**][**connected to a phase selector switch**].
f. AC ammeter, [**for each phase**][**connected to a phase selector switch**].
g. AC frequency meter.
h. Generator-voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices and common visual alarm indication including the following:

a. Cranking control equipment.
b. Run-Off-Auto switch.
c. Control switch not in automatic position alarm.
d. Overcrank alarm.
e. Overcrank shutdown device.
f. Low water temperature alarm.
g. High engine temperature pre-alarm.
h. High engine temperature.
i. High engine temperature shutdown device.
j. Overspeed alarm.
k. Overspeed shutdown device.
l. Low fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required [**for the indicated EPSS class**][**in "Fuel Tank Capacity" Subparagraph in "Diesel Fuel-Oil System" Article**].

m. Coolant low-level alarm.
n. Coolant low-level shutdown device.
o. Coolant high-temperature prealarm.
p. Coolant high-temperature alarm.
q. Coolant low-temperature alarm.
r. Coolant high-temperature shutdown device.
s. EPS supplying load indicator.
t. Battery high-voltage alarm.
u. Low cranking voltage alarm.
v. Battery-charger malfunction alarm.
w. Battery low-voltage alarm.
x. Lamp test.

y. Contacts for local and remote common alarm.
z. Low-starting air pressure alarm.
aa. Low-starting hydraulic pressure alarm.
bb. Remote manual stop shutdown device.
cc. Air shutdown damper alarm when used.
dd. Air shutdown damper shutdown device when used.
ee. Generator overcurrent-protective-device not-closed alarm.
ff. Hours of operation.
gg. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

G. Engine Generator Metering: Comply with [**Section 260913 "Electrical Power Monitoring and Control."**][**Section 262713 "Electricity Metering."**][**Section 260913 "Electrical Power Monitoring and Control" and Section 262713 "Electricity Metering."**]

H. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via [**ModBus**][**LonWorks**][**Ethernet**]<**Insert data protocol**>. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

I. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

J. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature pre-alarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low cranking voltage alarm.
19. Generator overcurrent-protective-device not-closed alarm.

K. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

L. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.8 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Molded-case circuit breaker, thermal-magnetic type; 100 percent rated; complying with UL 489:

a. Tripping Characteristic: Designed specifically for generator protection.
b. Trip Rating: Matched to generator output rating.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

2. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to or integrated with control and monitoring panel.

3. Insulated-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

4. Molded-case type disconnect switch; 100 percent rated:

a. Trip Rating: Matched to generator output rating.
b. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.

2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.
2. Trip generator protective device on ground fault.

2.9 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: [**Class H**][**or**][**Class F**].

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide [**six**][**12**]-lead alternator.

E. Range: Provide [**limited**][**broad**][**extended**] range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified[**and as required by NFPA 110**].

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within [**15**][**20**][**30**] percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within [**5**][**10**][**15**] percent and stabilize at rated frequency within [**2**][**5**] seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: [**12**]<**Insert number**> percent, maximum.

2.10 LOAD BANK

A. Description:

1. Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, [**resistive**][**resistive and reactive**] unit capable of providing a balanced three-phase, delta-connected load to engine generator at [**100**]<**Insert number**> percent rated-system capacity, at [**80**]<**Insert number**> percent power factor, lagging.[**Unit may contain separate resistive and reactive load banks controlled by a common control panel.**] Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.
2. Permanent, radiator-mounted[**, resistive**] unit capable of providing a balanced three-phase, delta-connected load to engine generator at [**50**][**70**]<**Insert number**> percent rated-system capacity. Unit shall be capable of selective control of load in 25 percent steps of load-bank rating and with minimum step changes of approximately 5 and 10 percent available.

B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and stainless-steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases. Galvanized steel is prohibited. Element's maximum resistance shall be between 100 and 105 percent of rated resistance.

C. Reactive Load Elements: Epoxy-encapsulated reactor coils.

D. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

E. Load-Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

F. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

G. Load-Bank Enclosures: NEMA 250, Type 3R, aluminized steel complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with **1/2-inch- (13-mm-)** square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge. Components other than resistive elements shall receive exterior epoxy coating with compatible primer. Comply with requirements in Section 099600 "High-Performance Coatings."

H. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.

I. Load-Bank Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

J. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.11 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description:

1. Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to **100 mph**

(160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

2. Prefabricated or preengineered, galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure; erected on concrete foundation.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph (160 km/h).

C. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Fire Protection: Provide fire protection according to Section 211000 "Water-Based Fire-Suppression Systems." Provide smoke detector in enclosure; mounted according to NFPA 72.

E. Hinged Doors: With padlocking provisions.

F. Space Heater: [**Gaseous**][**Electric**]. Thermostatically controlled and sized to prevent condensation.

G. Lighting: Provide weather-resistant [**fluorescent**][**LED**] lighting with [30 fc (330 lx)][50 fc (550 lx)] average maintained.

H. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

I. Muffler Location: [**Within**][**External to**] enclosure.

J. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

K. Interior Lights with Switch: Factory-wired, vaporproof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

L. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

2.12 REMOTE RADIATOR MOTORS

A. Description: NEMA MG 1, Design B, medium-induction, random-wound, squirrel-cage motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Temperature Rise: Match insulation rating.

G. Code Letter Designation:

1. Motors [**15**]<**Insert number**> HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than [**15**]<**Insert number**> HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.13 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: [**Standard neoprene**][**Natural rubber**][**Bridge-bearing neoprene, complying with AASHTO M 251**] separated by steel shims.
2. Shore A Scale Durometer Rating: [**30**][**40**][**45**][**50**][**60**][**65**][**70**]<**Insert number**>.
3. Number of Layers: [**One**][**Two**][**Three**][**Four**]<**Insert number**>.
4. Minimum Deflection: [**1 inch (25 mm)**]<**Insert value**>.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to **1/4-inch- (6-mm-)** thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: [**1 inch (25 mm)**]<**Insert value**>.

C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connectors materials for steel piping.

D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.14 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.15 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with IEEE 115[**and with NFPA 110, Level 1 Energy Converters**].

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections to verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions[**and with NFPA 110**].

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators[**and remote radiators mounted on grade**]. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install [**packaged engine generator**][**engine generator in a walk-in enclosure**] with [**elastomeric isolator pads**][**restrained spring isolators**] having a minimum deflection of [**1 inch (25 mm)**]<**Insert static deflection**> on **4-inch- (100-mm-)** high concrete base. Secure [**sets**][**enclosure**] to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Remote Radiators:

    a. Install remote radiator with [**elastomeric isolator pads**][**restrained spring isolators**] on [**concrete base on grade**][**roof equipment supports on roof**].
    b. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Section 077200 "Roof Accessories."

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Cooling System: Install Schedule 40 black steel piping with welded joints for cooling water piping between engine generator and [**heat exchanger**][**remote radiator**]. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."

1. Install isolating thimbles where exhaust piping penetrates combustible surfaces. Provide a minimum of **9 inches (225 mm)** of clearance from combustibles.
2. Insulate cooling system piping and components according to requirements in Section 230719 "HVAC Piping Insulation."

F. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
2. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
3. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of **9 inches (225 mm)** of clearance from combustibles.

G. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

H. Fuel Piping:

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are

specified in Section 231113 "Facility Fuel-Oil Piping."
2. Natural gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural Gas Piping."
3. Copper and galvanized steel shall not be used in the diesel fuel-oil piping system.

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine generator and [**remote radiator**][**heat exchanger**] with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Fuel Connections:

1. Connect fuel piping to engines with a gate valve and union and flexible connector.
2. Install manual shutoff valve in a remote location to isolate gas supply to the generator.
3. Vent gas pressure regulators outside building a minimum of **60 inches (1500 mm)** from building openings.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the generator set from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.
3. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

4. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs, as specified in NETA ATS. Certify compliance with test parameters.

    a. Visual and Mechanical Inspection:

        1) Compare equipment nameplate data with Drawings and the Specifications.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, and grounding.
        4) Verify that the unit is clean.

    b. Electrical and Mechanical Tests:

        1) Perform insulation-resistance tests according to IEEE 43.

            a) Machines Larger Than **200 hp (150 kW)**: Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines **200 hp (150 kW)** or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

        2) Test protective relay devices.
        3) Verify phase rotation, phasing, and synchronized operation as required by the application.
        4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
        5) Perform vibration test for each main bearing cap.
        6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding **40-inch wg (120 kPa)**. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at [**four**]<**Insert number**> locations [**25 feet (8 m) from edge of the generator enclosure**][**on the property line**]<**Insert location for measurement**>, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and [**retest**][**reinspect**] as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**12**]<**Insert number**> months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 32 13 19

SECTION 26 33 43 00 - BATTERY CHARGERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes battery chargers for emergency engine generators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of battery charger.

1. Include system overview, construction details, material descriptions, and dimensions of battery charging and monitoring systems.
2. Include rated capacities, operating characteristics, electrical characteristics, performance specifications, and furnished accessories.

B. Shop Drawings: For battery chargers.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field installation, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include instructions for Installer.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Seismic Qualification Data: Certificates, for battery changers, accessories, and components, from manufacturer.

1. Basis for Certification: Include Certificate of Compliance for nonstructural components and systems. Withstand certification is for below-grade, grade, and roof-level installations, installations in essential facilities, and for life-safety applications, based on actual shake-testing. Certified installation locations shall include mounting directly to structural wall and directly to nonstructural wall.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For battery chargers to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's operating specifications and user's guides.
b. Data sheet for each battery charger with nameplate information and performance

specifications.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide certification that manufacturer complies with requirements of ISO 9001.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of battery chargers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 1236 for Category BBHH. OEM-supplied, open-frame chargers may be UL recognized to Category BBHH provided they are housed in a listed enclosure.

C. NFPA Compliance: Comply with NFPA 110.

D. Environmental Conditions: Battery charger shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: **Minus 40 to plus 158 deg F (minus 40 to plus 70 deg C)** with full charger output available up to **104 deg F (40 deg C)**.
2. Relative Humidity: 5 to 95 percent.
3. Altitude: Meets full performance from sea level to **5000 feet (1600 m)**. Chargers installed at higher altitudes may automatically derate output power to prevent overheating of internal components, but shall remain operable.
4. Electromagnetic Immunity: Charger power terminals shall be immune to conducted and radiated electromagnetic energy to IEC 61000-4-12.
5. Vibration Resistance: Charger enclosure rated to IEC 60068-2-6 vibration test; 4-g force from 18 to 500 Hz on 3 axes; and 0.01 power spectral density value from 20 to 500 Hz.

E. Seismic Performance: Battery chargers shall withstand the effects of earthquake motions determined according to [**IBC 2006**][**IBC 2009**][**IBC 2012**][**IBC 2015**][**the latest edition of the IBC**][**ASCE/SEI 7**]<**Insert requirement**>.

1. Shake-Table Testing: Comply with ICC-ES AC156.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
3. Component Importance Factor: [**1.5**][**1.0**].
4. Equipment seismic application, spectral response acceleration, short period (Sds) for Project is

[**indicated on Drawings**]<**Insert requirements**>.

F. Battery-Charger Power Conversion Energy Efficiency:

1. Certified to California Code of Regulations, Title 20, "Appliance Efficiency Regulations"; https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx.
2. Comply with Oregon Department of Energy standards for appliance energy efficiency.

2.2 BATTERY CHARGERS FOR EMERGENCY ENGINE GENERATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Cummins Power Generation**]
2. [**GE Power; General Electric Company**]
3. [**Stored Energy Systems LLC**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Cummins Power Generation**]
2. [**GE Power; General Electric Company**]
3. [**Stored Energy Systems LLC**]
4. <**Insert manufacturer's name**>

C. Source Limitations: Obtain battery chargers from single source from single manufacturer.

D. Battery-Charger Operation: Current-limited, constant-voltage, automatic-boost type charger designed for [**lead-acid**][**nickel-cadmium**] batteries, with the following features:

1. Automatic Boost Mode: Operates in boost charging mode after battery discharge. Boost duration automatically adjusted depending on the following:

   a. Differing depths of battery discharge.
   b. Differing relationships of battery amp-hour capacity to charger ampere output.
   c. Differing parasitic direct current loads.

2. Output Voltage Regulation: Charger regulates output to within plus or minus 0.5 percent of manufacturer-provided voltage settings despite variations of input voltage, input frequency, and output current.
3. Battery Thermal Compensation: Battery temperature compensation with adjustable slope, factory set at minus 0.18 percent per degree C, and equipped for sensing battery temperature.[**Include battery temperature sensor mounted on battery negative terminal.**]
4. Automatic Dead Battery Recharge: Charger automatically recharges a battery discharged to 0 V at full-rated output current, without the need for user intervention.
5. AC Input: Charger operates from any 47- to 63-Hz ac source with voltage ranging from 90- to 265-V rms.
6. Lead-Acid Battery Longevity and Safety Mode: Charger emulates vehicle duty for which starting batteries are designed to maximize battery life, minimize battery explosion risk, and minimize electrolyte loss in lead-acid batteries:

   a. Boost Mode Recharge: After recharge is complete in boost mode, charger reverts to a voltage just above battery open-circuit voltage, for the majority of battery-charger operating

hours, when fully charged. The charger remains in operation to prevent battery discharge.

b. Float Mode: Charger periodically elevates output voltage to ensure a fully charged battery, charger then returns to just above battery nominal voltage. Charger repeats this this cycle until the next battery discharge, when the battery shall be recharged in the boost mode.

7. Charger Enclosure: NEMA 250, [**Type 1 (IP20)**][**Type 3R (IP22)**], wall mounted and rated for generator duty with charger enclosure vibration resistance. Housing materials: aluminum or stainless steel.

E. Battery-Charger Status Indication and Alarms:

1. Output Voltage and Current: Digital or analog meters on front panel, or by conveying performance data to generator control panel via J-1939 datalink. Accuracy: Plus 2 percent for voltage and plus 5 percent for current.
2. Alarm Outputs: [**Individual Form C contacts**][**Single summary Form C contact**], or by conveying alarms to generator control panel via J-1939 datalink.

a. AC voltage failure.
b. Low dc voltage.
c. High dc voltage.
d. Low cranking voltage.

2.3 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to evaluate battery-charger fabricator's quality-control and testing methods.

B. Testing: Test and inspect battery chargers according to UL 1236 for Category BBHH recharge performance.

C. Factory Tests: Test and inspect assembled battery chargers to manufacturer's written instructions. Verify NFPA 110 recharge performance by validating that battery charger is listed to UL 1236 Category BBHH on the UL certification database.

D. Battery charger will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, mounting locations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting battery-charger performance.

B. Examine roughing-in for conduit systems and electrical connections to verify actual locations of connections before battery-charger installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BATTERY-CHARGER INSTALLATION

A. Follow manufacturer's written instructions to prevent damage from static electricity. Provide clearances for service and ventilation.

B. Battery chargers are configured at the factory. If settings need to be field-configured, follow manufacturer's setup written instructions.

C. Coordinate jumper datalinks with emergency generator control panel capabilities.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide branch-circuit overcurrent protection.

C. Comply with requirements for branch-circuit protection and service disconnects in Section 262816 "Enclosed Switches and Circuit Breakers."

3.4 IDENTIFICATION

A. Identify system components according to Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with authorities having jurisdiction**][**with the assistance of a factory-authorized service representative**]:

1. Verify that certification labels are properly installed. Verify NFPA 110 compliance by validating that battery charger is listed to UL 1236 Category BBHH on the UL certification database.
2. Verify that connections are secure and in the proper locations. Ensure wiring is correctly connected between charger and battery.
3. Operational Test: After electrical circuitry has been energized, apply input voltage to confirm proper unit operation.
4. Test and adjust alarms, display indicators, controls, and safeties.

D. Battery charger will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain battery chargers and related equipment.

B. Coordinate this training with that for emergency engine generator equipment.

END OF SECTION 26 33 43 00

SECTION 26 33 43 00A - PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public address systems.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding equipment referenced by this Section.
6. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
7. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-[**and wind-**]control devices referenced by this Section.
8. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
9. Section 262716 "Electrical Cabinets and Enclosures" specifies rack or frame system enclosures referenced by this Section.
10. Section 270528 "Pathways for Communications Systems"[**and Section 271100 "Communications Equipment Room Fittings"**] specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.
11. Section 284600 "Fire Detection and Alarm" specifies fire-alarm system interfaces referenced by this Section.
12. Section 284700 "Mass Notification" specifies mass notification system interfaces referenced by this Section.

1.2 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. FAS: Fire alarm system.

C. I&TFAS: Inspection and testing of fire alarm system.

D. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.

E. SPDT: Single pole, double throw.

F. VU: Volume unit.

G. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

B. Shop Drawings: For power, signal, and control wiring.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
3. Console layouts.
4. Control panels.
5. Rack arrangements.
6. Calculations: For sizing backup battery.
7. Wiring Diagrams: For power, signal, and control wiring.

a. Identify terminals to facilitate installation, operation, and maintenance.
b. Single-line diagram showing interconnection of components.
c. Cabling diagram showing cable routing.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra stock material.

1.6 QUALIFICATIONS

A. Fire-Alarm Systems (FAS) Technician Trainee: Having at least six months of experience and possessing active NICET FAS Level I certification. Able to perform limited tasks under direct supervision.

B. Fire-Alarm Systems (FAS) Associate Engineering Technician: Having at least two years of experience and possessing active NICET FAS Level II certification. Able to review drawings, specifications, codes, and standards; to conduct basic installation activities; and to perform basic troubleshooting.

C. Fire-Alarm Systems (FAS) Engineering Technician: Having at least five years of experience and possessing active NICET FAS Level III certification. Able to perform system layout activities, to supervise Level I and Level II technicians, to provide submittal packages, and to interact with authorities having jurisdiction.

D. Fire-Alarm Systems (FAS) Senior Engineering Technician: Having at least 10 years of experience and possessing active NICET FAS Level IV certification. Able to manage multiple projects at once, to interpret codes and standards, to conduct training, and to serve as liaison between authorities having jurisdiction, owners, engineers, and contractors.

E. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and to prepare related records and reports.

F. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke-control interfaces, air-sampling systems, multi-zone voice evacuation systems, or high-rise applications) and to prepare related records and reports.

G. Fire-Alarm Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate fire-alarm cabling.

1. On-site fire-alarm cable installation supervisor must possess active NICET FAS [**Senior**]Engineering Technician certification.

H. Fire-Alarm Testing Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician **[I][II]** certification.

I. Communications Design Professional: Design professional possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Expertise in design of communications infrastructure and distribution equipment.
2. BICSI Registered Communications Distribution Designer (RCDD)[**or Outside Plant Designer (OSP)**] certification.

J. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000

"Quality Requirements" and the following:

1. Training and manufacturer certification to install, splice, and terminate communications cabling.
2. Installation Supervisor: BICSI Technician (TECH) certification.
3. Copper Installers: [**30 percent**]<**Insert quantity**> of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

K. Communications Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**]<**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**]<**Insert code enforced by authorities having jurisdiction**> testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Functional Description:

1. Selectively connect any zone to any available signal channel.
2. Selectively control sound from microphone outlets and other inputs.
3. "All-call" feature must connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Telephone paging adapter must allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation, including standby mode with inputs off, and output free of nonuniform coverage of amplified sound.
7. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
8. Equipment must be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
9. Equipment Mounting: Where rack or cabinet mounting is indicated, equipment must be designed to mount in a **19 inch (483 mm)** housing complying with Section 262716 "Electrical Cabinets and Enclosures."

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.

4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 PUBLIC ADDRESS SYSTEMS

A. UL AZOT - Public Address System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altec Lansing Technologies, Inc**]
   b. [**Atlas Sound LP**]
   c. [**Bogen Communications, Inc**]
   d. [**Bosch Security Systems, Inc.**]
   e. [**Edwards; Carrier Global Corporation**]
   f. [**Federal Signal Corporation**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altec Lansing Technologies, Inc**]
   b. [**Atlas Sound LP**]
   c. [**Bogen Communications, Inc**]
   d. [**Bosch Security Systems, Inc.**]
   e. [**Edwards; Carrier Global Corporation**]
   f. [**Federal Signal Corporation**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain public address system from single source from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Audio Equipment: UL CCN AZOT, including UL 62368-1[**; or UL CCN AZJX, including UL 813**][**; or UL CCN AZSQ, including UL 60065**].
   b. Weather-Resistant Equipment: Marked for use in wet or damp locations.

B. Preamplifiers:

1. Separately mounted.
2. Integral to power amplifier.
3. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
4. Total Harmonic Distortion: Less than 1 percent.
5. Frequency Response: Within plus or minus 2 dB from 20 to 20 000 Hz.
6. Input Jacks: Minimum of three. One matched for low-impedance microphone; one USB port; and the other matchable to DVD or CD player, or radio tuner signals without external adapters.
7. Minimum Noise Level: Minus 55 dB below rated output.
8. Controls: On-off, input levels, and master gain.

C. Power Amplifiers:

1. Mounting: [**Console**][**Rack**].
2. Output Power: 70 V balanced line. [**80 percent of the sum of wattage settings of connected**]<**Insert wattage**> for each station and speaker connected in all-call mode of operation, plus a [**10 percent**][**15 percent**][**25 percent**] allowance for future stations.
3. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12 000 Hz.
4. Minimum Signal-to-Noise Ratio: 80 dB, at rated output.
5. Frequency Response: Within plus or minus 3 dB from 20 to 12 000 Hz.
6. Output Regulation: Less than 2 dB from full to no load.
7. Controls: On-off, input levels, and low-cut filter.
8. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

D. Transfer to Standby Amplifier:

1. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

E. Paging Microphone:

1. Type: Dynamic, with [**cardioid**][**omnidirectional**] polar characteristic.
2. Impedance: [**500 Ω**][**250 Ω**].
3. Frequency Response: Uniform, 50 to 15 000 Hz.
4. Sensitivity: Minus 70 dB.
5. Output Level: Minus 58 dB, minimum.
6. Cable: Braided shield cable with [**Amphenol**][**Neutrik**] XLR connectors. Coordinate impedance with microphone impedance.
7. Mounting: Desk stand with integral-locking, press-to-talk switch.

F. <**Insert requirements for other microphone types**>.

G. Volume Limiter/Compressor Minimum Performance Requirements:

1. Frequency Response: 45 to 15 000 Hz, plus or minus 1 dB minimum.
2. Reduction Ratio: Automatically vary compression ratio, and attack and release times for voice and music inputs.

    a. Compression Ratio Range: 3:1 to 10:1 minimum.
    b. Averaging Compressor Attack Time: Up to 500 ms.
    c. Signal Fast Compression Attack Time: Less than 10 ms.
    d. Release time: Up to 500 ms.

3. Distortion: 0.5 percent, maximum.
4. Rated Output: Minimum of plus 14 dB.
5. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
6. Rack mounted.

H. Control Console Enclosure:

1. Cabinet: Modular, [**desktop**][**desk style**]; complying with EIA/ECA-310-E.
2. Housing: Steel, **0.0478 inch (1.2 mm)** minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
3. Panel for Equipment and Controls: Rack mounted.
4. Controls:

a. Switching devices to select signal sources for distribution channels.
b. Program selector switch to select source for each program channel.
c. Switching devices to select zones for paging.
d. All-call selector switch.

5. Indicators: A visual annunciation for each distribution channel to indicate source being used.
6. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.
7. Spare Positions: 20 percent spare zone control and annunciation positions on console.
8. Microphone jack.

I. Equipment Cabinet Enclosure:

1. Comply with requirements in Section 262716 "Electrical Cabinets and Enclosures."
2. House amplifiers and auxiliary equipment at each location.
3. Cabinet Housing:

a. Front- and rear-locking doors.
b. Arranged for floor or wall mounting as indicated.
c. Sized to house all equipment indicated, plus spare capacity.
d. Include [**20**]<**Insert number**> percent minimum spare capacity for future equipment in addition to space required for[**future**] DVD or CD player.

4. Power Provisions: A single switch in cabinet disconnects cabinet power distribution system and electrical outlets, which must be uniformly spaced to accommodate AC power cords for each item of equipment.
5. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan must be equipped with a filtered input vent and must be connected to operate from 105 to 130 V(ac), 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

J. Equipment Rack Enclosure:

1. Racks: **19 inch (483 mm)** standard, complying with requirements in Section 262716 "Electrical Cabinets and Enclosures."
2. Power-Supply Connections: Compatible plugs and receptacles.
3. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
4. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
5. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with cartridge fuse protection for rack equipment power.
6. Service Light: At top rear of rack with an adjacent control switch.
7. Vertical Plug Strip: Grounded receptacles, **12 inch (300 mm)** on center; the full height of rack for public address system equipment use only.
8. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
9. Spare Capacity: [**20**]<**Insert number**> percent in rack for future equipment.

K. Telephone Paging Adapter:

1. Adapters must accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.

a. Minimum Frequency Response: Flat, 200 to 2500 Hz.
b. Impedance Matching: Adapter matches telephone line to public address equipment input.
c. [**Rack**][**Cabinet**] mounted.

L. Tone Generator:

1. Provide clock and program interface with public address system.
2. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
3. Pitch Control: Chimes and tone.
4. Volume Control: All outputs.
5. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.
6. Mounting: [**Rack**][**Cabinet**].

M. Monitor Panel:

1. Monitor power amplifiers.
2. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
3. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
4. Mounting: [**Rack**][**Cabinet**].

N. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1 W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15 000 Hz.
3. Size: [**6 inch (150 mm)**][**8 inch (200 mm)**] with **1 inch (25 mm)** voice coil and minimum **5 oz (140 g)** ceramic magnet.
4. Rated Output Level: [**8**][**10**] W.
5. Minimum Dispersion Angle: 100 degrees.
6. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
7. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least **0.0478 inch (1.2 mm)** steel and whole assembly rust proofed and shop primed for field painting.
8. Flush-Ceiling-Mounted Units: In steel back boxes, acoustically dampened. Metal ceiling grille with [**white**]<**Insert color**> baked enamel.

O. Horn-Type Loudspeakers:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12 000 Hz.
4. Dispersion Angle: 130 by 110 degrees.
5. Mounting: Integral bracket.
6. Units in Damp, Wet, or Outdoor Locations: Listed and labeled for environment in which they are located.
7. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located. Provide any accessories required to maintain listing.

P. Noise-Operated Gain Controller:

1. Gain controller must be designed to continuously sense space noise level and automatically adjust signal level to local speakers.
2. Frequency Response: 20 to 20 000 Hz, plus or minus 1 dB.
3. Level Adjustment Range: 30 dB minimum.
4. Maximum Distortion: 0.5 percent.

5. Control: Permits adjustment of sensing level of device.

Q. Outlets:

1. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.

   a. Wattage Rating: 10 W unless otherwise indicated.
   b. Attenuation per Step: 3 dB, with positive off position.
   c. Insertion Loss: 0.4 dB maximum.
   d. Attenuation Bypass Relay: SPDT. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
   e. Label: "PA Volume."

2. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
3. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

R. Battery Backup Power Unit:

1. Rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
2. Supplies public address equipment with 12 to 15 V(dc) power automatically during an outage of normal 120 V(ac) power.
3. Float charge batteries when not supplying system and able to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
4. Automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

S. Conductors and Cables:

1. Jacketed, twisted pair and twisted multipair, untinned solid copper.

   a. Insulation for Wire in Conduit: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.
   b. Microphone Cables: Neoprene jacketed, not less than **2/64 inch (0.8 mm)** thick, over shield with filled interstices. Shield 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
   c. Plenum Cable: Listed and labeled for plenum installation.

T. Conduits and Boxes:

1. Flexible metal conduit is not permitted.
2. Outlet Boxes: Not less than **2 inch (50 mm)** wide, **3 inch (75 mm)** high, and **2-1/2 inch (64 mm)** deep.

2.3 MAINTENANCE MATERIAL ITEMS

A. Extra Stock Material: Furnish to Owner extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Microphone: [**One**]<**Insert number**>.
2. Microphone Desk Stand(s): [**One**]<**Insert number**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF COMMUNICATIONS CABLE PATHWAYS

A. Comply with NECA NEIS 1.

B. Special Installation Techniques:

1. Install manufactured conduit sweeps and long-radius elbows whenever possible.
2. Wiring Method:

    a. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters[**, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal pathway and cables except in unfinished spaces.

        1) Install plenum cable in environmental air spaces, including plenum ceilings.
        2) Install pathways and boxes for communications cabling.

    b. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
4. Terminate conductors; no cable may contain unterminated elements. Make terminations only at outlets and terminals.
5. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
6. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used.
10. Open-Cable Installation:

    a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
    b. Suspend speaker cable not in a wireway or pathway a minimum of **8 inch (200 mm)** above ceiling by cable supports not more than [**60 inch (1524 mm)**]<**Insert dimension**> apart.
    c. Do not run cables through structural members or in contact with pipes, ducts, or other potentially damaging items.

11. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least **12 inch (300 mm)** apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by

equipment manufacturer.

3.2 INSTALLATION OF PUBLIC ADDRESS SYSTEM

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, and NECA NEIS 305.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
2. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
3. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
4. Equipment Cabinets and Racks:

    a. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
    b. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
    c. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

5. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.
6. Wall-Mounted Outlets: Flush mounted.
7. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.
8. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than 18 AWG and conductors from microphone receptacles to amplifiers not smaller than 22 AWG.
9. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
10. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on the Drawings.

D. Interfaces with Other Work:

1. Seal penetrations of rated walls and partitions.
2. Identification: Provide labels for public address system equipment and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.

b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3. Grounding and Bonding:

a. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
b. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
c. Install grounding electrodes.

3.3 FIELD QUALITY CONTROL OF PUBLIC ADDRESS SYSTEM

A. Administrant for Communications Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a

signal generator using a 1000 Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
b. Repeat test for each separately controlled zone of loudspeakers.
c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12 000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12 000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground.
9. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

F. Nonconforming Work:

1. Public address system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to the Project during other-than-normal occupancy hours for this purpose.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 017900 "Demonstration and Training."

3.7 PROTECTION

A. After installation, protect public address system equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 33 43 00A

Task	Specification	Specification Description
26 33 43 00	27 52 23 00	Nurse Call Code Blue Systems

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SECTION 26 33 53 00 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UPS systems.
2. Surge suppression.
3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Output distribution section.
9. Output isolation transformer.
10. Remote status and alarm panel.
11. Remote monitoring.
12. Battery.
13. Basic battery monitoring.
14. Additional battery monitoring.
15. Battery-cycle warranty monitoring.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of UPS.

1. UPS systems.
2. Surge suppression.
3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Output distribution section.
9. Output isolation transformer.
10. Remote status and alarm panel.
11. Remote monitoring.
12. Battery.
13. Basic battery monitoring.
14. Additional battery monitoring.
15. Battery-cycle warranty monitoring.

B. Shop Drawings: For UPS.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
4. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory test reports.
2. Manufacturer's field reports for field quality-control support.

1.4 CLOSEOUT SUBMITTALS

A. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

1.5 WARRANTY FOR UPS SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed UPS system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that UPS system performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

1.6 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period for Ni-Cd Batteries: [**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**],

freight prepaid.

2. Follow-On Extended-Warranty Period for Ni-Cd Batteries: [**15**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
3. Additional Warranted Cycle Life Criteria for Standard Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F**:

    a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.
    b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
    c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

4. Additional Warranted Cycle Life Criteria for Premium Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F**:

    a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 40 discharge cycles.
    b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 125 discharge cycles.
    c. For discharge rate not faster than 15 minutes, discharge duration not longer than 90 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 750 discharge cycles.

5. Additional Warranted Cycle Life Criteria for Flooded (Wet Cell or Open) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F** and preventive maintenance performed in accordance with manufacturer's published instructions:

    a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 40 discharge cycles.
    b. For discharge rate not faster than one hour, discharge duration not longer than one hour, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 80 discharge cycles.
    c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 2700 discharge cycles.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. UL Compliance: Listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with UL 1778.

B. NFPA Compliance: UPS components must be listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for installation in computer rooms in accordance with NFPA 75.

C. The UPS must perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state AC input voltage deviates up to plus or minus [**10**][**15**] percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is [**30**][**50**][**100**] percent unbalanced continuously.

D. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is [**five**][**10**][**15**]<**Insert duration**> minutes.

E. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state AC input voltage varies plus 10 percent and minus [**15**][**20**][**30**] percent from nominal voltage.

F. Overall UPS Efficiency: Equal to or greater than [**94**][**95**]<**Insert number**> percent at 100 percent load, [**94**][**95**]<**Insert number**> percent at 75 percent load, and [**93**][**94**]<**Insert number**> percent at 25 percent load.

G. Maximum Acoustical Noise: <**Insert value**>, "A" weighting, emanating from any UPS component under any condition of normal operation, measured <**Insert distance**> from nearest surface of component enclosure.

H. Maximum Energizing Inrush Current: [**Six times the full-load current**][**Eight times the full-load current**][**Soft start linear input current rise to 100 percent over a 1- to 40-second period, factory set at 10 seconds**].

I. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

J. AC Output-Voltage Regulation for Loads 100 Percent Balanced: Maximum of plus or minus 1 percent over the full range of battery voltage.

K. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

L. Limitation of harmonic distortion of input current to the UPS must be as follows:

1. Rectifier-charger circuits must limit THD to 5 percent, maximum, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.
2. THD is limited to a maximum of 32 percent, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30.

M. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for [**100 percent rated nonlinear load current**][**rated full load with THD up to 50 percent**], with a load crest factor of 3.0.

N. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 200 percent for 60 seconds in normal operation, and 150 percent for 30 seconds in battery operating mode.

O. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage must remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:

1. 50 Percent: Plus or minus 3 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

P. Input Power Factor: A minimum of [**0.90**][**0.95**] lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

Q. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging must not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:

1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

R. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.

2.2 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**APC by Schneider Electric**]
3. [**Eaton**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Mitsubishi Electric Automation, Inc**]
6. [**Staco Energy Products Co.**]
7. [**Toshiba International Corporation**]
8. <**Insert manufacturer's name**>

C. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

D. Enclosures: Comply with UL 50E, Type 1, unless otherwise indicated.

E. Configuration: [**Single-cabinet**][**Multicabinet**][**Field-assembled, multicabinet**] modular style units.

F. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

G. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

H. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

I. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future [**25**]<**Insert number**> percent increase in UPS capacity.

J. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) must be designed and fabricated to withstand static and seismic forces.

K. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

L. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.3 OUTPUT ISOLATION TRANSFORMER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APC by Schneider Electric**]
2. [**Eaton**]
3. <**Insert manufacturer's name**>

B. Description: [**Shielded unit**][**Unit**] with low forward transfer impedance up to 3 kHz, minimum. Include the following features:

1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately [**4**][**9**][**13**][**20**].
2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
3. Regulation: 5 percent, maximum, at rated nonlinear load current.
4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
5. Electrostatic Shielding of Windings: Independent for each winding.
6. Coil Leads: Physically arranged for minimum interlead capacitance.
7. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
8. Capacitive Coupling between Primary and Secondary: 33 pF, maximum, over a frequency range of 20 Hz to 1 MHz.

2.4 BATTERY

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**C&D Technologies, Inc.**]
2. [**Eaton**]
3. [**EnerSys**]
4. [**Exide Technologies**]
5. [**Panasonic Corporation of North America**]
6. <**Insert manufacturer's name**>

B. General Characteristics:

1. Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.

    a. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

2. Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, complete with battery disconnect switch and intercell connectors.

    a. Factory assembled in an isolated compartment of UPS cabinet.
    b. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks.
    c. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

3. Flooded, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.
4. Flooded cell, heavy-duty, industrial, Ni-Cd units in polypropylene containers. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks, complete with battery disconnect switch and intercell connectors.
5. Valve-regulated, heavy-duty, industrial, recombinant, pocket plate design, Ni-Cd units in polypropylene containers, complete with battery disconnect switch and intercell connectors.

    a. Factory assembled in an isolated compartment of UPS cabinet.
    b. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks.
    c. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

C. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) must be designed and fabricated to withstand static and seismic forces.

2.5 BASIC BATTERY MONITORING

A. Basic Battery Monitoring: Continuous, real-time capture of battery performance data.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alber**]
2. [**APC by Schneider Electric**]
3. [**BTECH, Inc**]
4. [**Canara**]
5. [**Eaton**]
6. [**Liebert; Vertiv Holdings Co.**]
7. [**Midtronics, Inc**]
8. [**Power Systems Specialists, Inc.**]
9. [**Staco Energy Products Co.**]
10. <**Insert manufacturer's name**>

C. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 Ω.

D. Battery compartment high-temperature detector initiates an alarm when smoke or a temperature greater

than **167 deg F** occurs within the compartment.

E. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than **167 deg F** occurs within the compartment.

F. Annunciation of Alarms: At UPS control panel and remotely.

2.6 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for UPS.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Product Certificates: For each product, from manufacturer.
4. Sample Warranties: For manufacturer's special warranties.

B. Factory Tests:

1. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
2. Factory Tests and Inspections: Test and inspect UPS system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with NETA ATS before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

a. Factory test complete UPS system before shipment. Use [**actual batteries that are part of final installation**][**the same type of batteries that are part of final installation**][**simulated battery testing**]. Include the following:

1) Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2) Full-load test.
3) Transient-load response test.
4) Overload test.
5) Power failure test.

3. Nonconforming Work:

a. Equipment that does not pass tests and inspections will be considered defective.

4. Factory Test Reports: Prepare and submit factory test and inspection reports. Include the following data:

a. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
b. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
c. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
3. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems."
4. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18 inch** centers around the full perimeter of concrete base **6 inch** from the outer edge of the base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.

E. Connections: Interconnect system components. Make connections to supply and load circuits in accordance with manufacturer's wiring diagrams unless otherwise indicated. Apply oxide inhibitor on battery terminals.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Inspect interiors of enclosures, including the following:

a. Inspect anchorage, alignment, grounding, and required clearances.
b. Component type and labeling verification.
c. Ratings of installed components.

2. Test electrical and mechanical interlock systems for correct operation and sequencing.
3. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of low-resistance ohmmeter in accordance with Section 7.22.2.2 of NETA ATS.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published instructions or Table 100.12 of NETA ATS.
    c. Perform thermographic survey in accordance with Section 9 of NETA ATS.

4. Test static transfer from inverter to bypass and back. Use normal load, if possible.
5. Test DC undervoltage trip level on inverter input breaker. Set in accordance with manufacturer's published instructions.
6. Verify synchronizing indicators for static switch and bypass switches.
7. Test insulated-case and molded-case breakers.

    a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published instructions. In the absence of manufacturer's published instructions, use Table 100.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components, follow manufacturer's recommendation.
    c. Use primary current injection to determine long time and short time, ground fault, and instantaneous pickup, Use secondary current injection to test trip functions.
    d. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published instructions.
    e. Verify operation of charging mechanism.
    f. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.

8. Test automatic transfer switches.

    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Section 7.22.3.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.
    c. Perform a contact/pole-resistance test.
    d. Verify settings and operation of control devices.
    e. Calibrate and set all relays and timers in accordance with Section 7.9 of NETA ATS.
    f. Verify phase rotation, phasing, and synchronized operation as required by the application.
    g. Perform automatic transfer tests.

        1) Simulate loss of normal power.
        2) Return to normal power.
        3) Simulate loss of emergency power.
        4) Simulate all forms of single-phase conditions.

    h. Verify correct operation and timing of the following functions:

        1) Normal source voltage-sensing and frequency-sensing relays.

2) Time delay on transfer.
3) Alternative source voltage-sensing and frequency-sensing relays.
4) Automatic transfer operation.
5) Interlocks and limit switch function.
6) Time delay and retransfer on normal power restoration.

9. Test direct current system's batteries.

a. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
b. [**Verify electrolyte level. Measure electrolyte level, specific gravity, and temperature.**]
c. Inspect spill containment installation. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
d. Verify all charger functions and alarms.
e. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
f. Perform a load test in accordance with manufacturer's published instructions or IEEE 450.
g. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
h. Test values.

1) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Charger float and equalize voltage levels must be in accordance with battery manufacturer's published instructions.
3) The results of charger functions and alarms must be in accordance with manufacturer's published instructions.
4) Cell voltages must be within 0.05 V of each other or in accordance with manufacturer's published instructions.
5) Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state.
6) Results of load tests must be in accordance with manufacturer's published instructions or IEEE 450.

10. Test communication of status and alarms to remote monitoring equipment.
11. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous [**six months**]<**Insert time**> in accordance with NIST standards.

a. Simulate malfunctions to verify protective device operation.
b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
c. Test harmonic content of input and output current at 25, 50, and 100 percent of rated loads.
d. Test output voltage under specified transient-load conditions.
e. Test efficiency at 50, 75, and 100 percent of rated loads.
f. Test remote status and alarm panel functions.
g. Test battery-monitoring system functions.

D. Seismic-restraint tests and inspections must include the following:

1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
2. Test mounting and anchorage devices in accordance with requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Nonconforming Work:

1. The UPS system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Include references to manufacturers' published instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

END OF SECTION 26 33 53 00

SECTION 26 35 33 00 - POWER FACTOR CORRECTION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UPS systems.
2. Surge suppression.
3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Output distribution section.
9. Output isolation transformer.
10. Remote status and alarm panel.
11. Remote monitoring.
12. Battery.
13. Basic battery monitoring.
14. Additional battery monitoring.
15. Battery-cycle warranty monitoring.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. GTO: Gate turn-off thyristor.

B. IGBT: Isolated gate bipolar transistor.

C. PF: Power factor.

D. pF: Picofarads.

E. THD: Total harmonic distortion.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of UPS.

1. UPS systems.
2. Surge suppression.

3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Output distribution section.
9. Output isolation transformer.
10. Remote status and alarm panel.
11. Remote monitoring.
12. Battery.
13. Basic battery monitoring.
14. Additional battery monitoring.
15. Battery-cycle warranty monitoring.

B. Shop Drawings: For UPS.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
4. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Factory test reports.
2. Manufacturer's field reports for field quality-control support.

1.5 CLOSEOUT SUBMITTALS

A. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Spare Parts: Furnish to Owner spare parts, for repairing UPS system, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Fuses: [**One**]<**Insert number**> for every [**10**]<**Insert number**> of each type and rating, but no fewer than [**one**][**one set**]<**Insert number**> of each.

C. Consumable Items:

1. After completion of field quality control, startup, commissioning, adjusting, and closeout activities, replace air filters.
2. Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

a. Cabinet Ventilation Filters: [**One**]<**Insert number**> complete set(s).

1.7 WARRANTY FOR UPS SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed UPS system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that UPS system performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

1.8 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period for Ni-Cd Batteries: [**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
2. Follow-On Extended-Warranty Period for Ni-Cd Batteries: [**15**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
3. Additional Warranted Cycle Life Criteria for Standard Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

4. Additional Warranted Cycle Life Criteria for Premium Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 40 discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 125 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 90 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 750 discharge cycles.

5. Additional Warranted Cycle Life Criteria for Flooded (Wet Cell or Open) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)** and preventive maintenance performed in accordance with manufacturer's published instructions:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 40 discharge cycles.
b. For discharge rate not faster than one hour, discharge duration not longer than one hour, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 80 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 2700 discharge cycles.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:

1. Double Conversion, Standard Efficiency:

a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
c. Power Failure: If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.

2. Double Conversion, Line Interactive:

a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, with the rectifier-charger and inverter turned off and the battery disconnected.
b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the rectifier-charger and inverter turn on and the battery supplies energy to provide constant, regulated inverter power output to the load with minimum of 98 percent UPS system efficiency.
c. Power Failure: If normal power fails, there is a maximum 4 µs delay while the rectifier-charger and inverter turn on and the battery supplies energy to re-establish constant, regulated power output to the load.

3. Double Conversion, IGBT:

    a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output. High-efficiency carrier stored trench IGBT, in both rectifier-charger and inverter circuits, provides a minimum of 97 percent efficiency for the UPS system at full load and a minimum of 94 percent efficiency at 50 percent load.
    b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to provide constant, regulated inverter power output to the load.
    c. Power Failure: If normal power fails, the rectifier-charger and inverter use energy from the battery to supply constant, regulated power output to the load without switching or disturbance.

4. When power is restored at the normal supply terminals of the system, controls must automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger must supply power to the load through the inverter and simultaneously recharge the battery.
5. If the battery becomes discharged and normal supply is available, the rectifier-charger must charge the battery. The rectifier-charger must automatically shift to float-charge mode on reaching full charge.
6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch must switch the load to the normal AC supply circuit without disturbance or interruption.
7. The output power converters must produce up to 300 percent of rated full-load current for short-circuit clearing. The inverter must sustain steady-state overload conditions of up to 200 percent of rated full-load current for 60 seconds in normal operation.
8. The inverter must be capable of sustaining 150 percent of system capacity for 30 seconds while powered from the battery.
9. Should overloads persist past the time limitations, the automatic static transfer switch must switch the load to the bypass output of the UPS. When the fault has cleared, the static bypass transfer switch must return the load to the UPS system.
10. If the battery is disconnected, the UPS must supply power to the load from the normal supply with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal AC supply circuit without disturbance or interruption.
2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions described below without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS AC input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS AC supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal UPS AC supply terminals are energized and the load is supplied through the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

2.2 PERFORMANCE REQUIREMENTS

A. UL Compliance: Listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with UL 1778.

B. NFPA Compliance: UPS components must be listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for installation in computer rooms in accordance with NFPA 75.

C. The UPS must perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state AC input voltage deviates up to plus or minus [**10**][**15**] percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is [**30**][**50**][**100**] percent unbalanced continuously.

D. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is [**five**][**10**][**15**]<**Insert duration**> minutes.

E. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state AC input voltage varies plus 10 percent and minus [**15**][**20**][**30**] percent from nominal voltage.

F. Overall UPS Efficiency: Equal to or greater than [**94**][**95**]<**Insert number**> percent at 100 percent load, [**94**][**95**]<**Insert number**> percent at 75 percent load, and [**93**][**94**]<**Insert number**> percent at 25 percent load.

G. Maximum Acoustical Noise: <**Insert value**>, "A" weighting, emanating from any UPS component under any condition of normal operation, measured <**Insert distance**> from nearest surface of component enclosure.

H. Maximum Energizing Inrush Current: [**Six times the full-load current**][**Eight times the full-load current**][**Soft start linear input current rise to 100 percent over a 1- to 40-second period, factory set at 10 seconds**].

I. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

J. AC Output-Voltage Regulation for Loads 100 Percent Balanced: Maximum of plus or minus 1 percent over the full range of battery voltage.

K. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

L. Limitation of harmonic distortion of input current to the UPS must be as follows:

1. Rectifier-charger circuits must limit THD to 5 percent, maximum, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.
2. THD is limited to a maximum of 32 percent, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30.

M. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for [**100 percent rated nonlinear load current**][**rated full load with THD up to 50 percent**], with a load crest factor of 3.0.

N. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 200 percent for 60 seconds in normal operation, and 150 percent for 30 seconds in battery operating mode.

O. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage must remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:

1. 50 Percent: Plus or minus 3 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

P. Input Power Factor: A minimum of [**0.90**][**0.95**] lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

Q. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging must not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:

1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

R. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**APC by Schneider Electric**]
3. [**Eaton**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Mitsubishi Electric Automation, Inc**]
6. [**Staco Energy Products Co.**]
7. [**Toshiba International Corporation**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**APC by Schneider Electric**]
3. [**Eaton**]
4. [**Liebert; Vertiv Holdings Co.**]
5. [**Mitsubishi Electric Automation, Inc**]

6. [**Staco Energy Products Co.**]
7. [**Toshiba International Corporation**]
8. <**Insert manufacturer's name**>

D. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

E. Enclosures: Comply with UL 50E, Type 1, unless otherwise indicated.

F. Configuration: [**Single-cabinet**][**Multicabinet**][**Field-assembled, multicabinet**] modular style units.

G. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

H. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

I. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

J. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future [**25**]<**Insert number**> percent increase in UPS capacity.

K. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) must be designed and fabricated to withstand static and seismic forces.

L. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

M. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 SURGE SUPPRESSION

A. Protect internal UPS components from surges that enter at each AC power input connection including main disconnect switch, static bypass transfer switch[**, and maintenance bypass/isolation switch**]. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested in accordance with IEEE C62.41.1 and IEEE C62.41.2, [**Category B**][**Category C**].
2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 400 Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.

2.5 RECTIFIER-CHARGER

A. Description: Voltage source converter, [**six**][**12**]-pulse [**IGBT**][**GTO**] rectifier.

B. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

C. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

D. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

E. Battery Float-Charging Conditions: Comply with battery manufacturer's published instructions for battery terminal voltage and charging current required for maximum battery life. The battery charger must be matched to the battery type supplied.

F. Ni-Cd Battery Charger: Sense full charge by measuring the rate of temperature increase. Battery charging must be terminated when the rate of temperature rise reaches **1.8 deg F (1 deg C)** per minute. If the battery reaches **140 deg F (60 deg C)** prior to reaching this rate of temperature rise, charging must terminate. Chargers that determine full charge by voltage measurement to sense a 10 mV drop per cell when reaching full charge are also acceptable.

2.6 INVERTER

A. Description:

1. Pulse-width modulated, [**carrier stored trench IGBT**][**IGBT**] with sinusoidal output.
2. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.7 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: [**Labeled LED**][**Plain-language messages on a digital LCD**].

1. Quantitative indications must include the following:

a. Input voltage, each phase, line to line.
b. Input current, each phase, line to line.
c. Bypass input voltage, each phase, line to line.
d. Bypass input frequency.
e. System output voltage, each phase, line to line.
f. System output current, each phase.
g. System output frequency.
h. DC bus voltage.
i. Battery current and direction (charge/discharge).
j. Elapsed time discharging battery.

2. Basic status condition indications must include the following:

    a. Normal operation.
    b. Load-on bypass.
    c. Load-on battery.
    d. Inverter off.
    e. Alarm condition.

3. Alarm indications must include the following:

    a. Bypass AC input overvoltage or undervoltage.
    b. Bypass AC input overfrequency or underfrequency.
    c. Bypass AC input and inverter out of synchronization.
    d. Bypass AC input wrong-phase rotation.
    e. Bypass AC input single-phase condition.
    f. Bypass AC input filter fuse blown.
    g. Internal frequency standard in use.
    h. Battery system alarm.
    i. Control power failure.
    j. Fan failure.
    k. UPS overload.
    l. Battery-charging control faulty.
    m. Input overvoltage or undervoltage.
    n. Input transformer overtemperature.
    o. Input circuit breaker tripped.
    p. Input wrong-phase rotation.
    q. Input single-phase condition.
    r. Approaching end of battery operation.
    s. Battery undervoltage shutdown.
    t. Maximum battery voltage.
    u. Inverter fuse blown.
    v. Inverter transformer overtemperature.
    w. Inverter overtemperature.
    x. Static bypass transfer switch overtemperature.
    y. Inverter power supply fault.
    z. Inverter transistors out of saturation.
    aa. Identification of faulty inverter section/leg.
    bb. Inverter output overvoltage or undervoltage.
    cc. UPS overload shutdown.
    dd. Inverter current sensor fault.
    ee. Inverter output contactor open.
    ff. Inverter current limit.

4. Controls must include the following:

    a. Inverter on-off.
    b. UPS start.
    c. Battery test.
    d. Alarm silence/reset.
    e. Output-voltage adjustment.

D. Dry-form "C" contacts must be available for remote indication of the following conditions:

1. UPS on battery.
2. UPS on-line.

3. UPS load-on bypass.
4. UPS in alarm condition.
5. UPS off (maintenance bypass closed).

E. Emergency Power off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.8 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer with a contactor or electrically operated circuit breaker to automatically provide electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full-load UPS current, minimum.

C. Input SPD: [**80**][**160**] kA.

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.

1. Switch must be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
2. Switch must electrically isolate other UPS components to permit safe servicing.
3. Switch must electrically isolate the rectifier-charger, inverter, and static bypass transfer switch from the load, but must allow primary power to the UPS for testing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full-load UPS current.

D. Mounting Provisions: [**Internal to system cabinet**][**Separate wall- or floor-mounted unit**].

E. Key interlock with key that is released only when the rectifier-charger and inverter are bypassed by the static bypass transfer switch. Key must be required to unlock maintenance bypass/isolation switch before switching from open (normal) position to closed position. Lock must be designed specifically for mechanical and electrical component interlocking.

2.10 OUTPUT DISTRIBUTION SECTION

A. Panelboards: Comply with Section 262416 "Panelboards," except provide assembly integral to UPS cabinet.

2.11 OUTPUT ISOLATION TRANSFORMER

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**APC by Schneider Electric**]

2. [**Eaton**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**APC by Schneider Electric**]
2. [**Eaton**]
3. <**Insert manufacturer's name**>

C. Description: [**Shielded unit**][**Unit**] with low forward transfer impedance up to 3 kHz, minimum. Include the following features:

1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately [**4**][**9**][**13**][**20**].
2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
3. Regulation: 5 percent, maximum, at rated nonlinear load current.
4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
5. Electrostatic Shielding of Windings: Independent for each winding.
6. Coil Leads: Physically arranged for minimum interlead capacitance.
7. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
8. Capacitive Coupling between Primary and Secondary: 33 pF, maximum, over a frequency range of 20 Hz to 1 MHz.

2.12 REMOTE STATUS AND ALARM PANEL

A. Description: Labeled LEDs on panel faceplate indicating [**five**]<**Insert quantity**> basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.

1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

2.13 REMOTE MONITORING

A. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:

1. Connectors and network interface units for data transmission via TIA-485, Ethernet, or web-based link.
2. Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computer are not included in this Section.
3. Software and Hardware: Compatible with that specified in Section 260913 "Electrical Power Monitoring and Control."

2.14 BATTERY

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [**C&D Technologies, Inc.**]
2. [**Eaton**]
3. [**EnerSys**]
4. [**Exide Technologies**]
5. [**Panasonic Corporation of North America**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**C&D Technologies, Inc.**]
2. [**Eaton**]
3. [**EnerSys**]
4. [**Exide Technologies**]
5. [**Panasonic Corporation of North America**]
6. <**Insert manufacturer's name**>

C. General Characteristics:

1. Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.

    a. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

2. Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, complete with battery disconnect switch and intercell connectors.

    a. Factory assembled in an isolated compartment of UPS cabinet.
    b. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks.
    c. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

3. Flooded, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.
4. Flooded cell, heavy-duty, industrial, Ni-Cd units in polypropylene containers. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks, complete with battery disconnect switch and intercell connectors.
5. Valve-regulated, heavy-duty, industrial, recombinant, pocket plate design, Ni-Cd units in polypropylene containers, complete with battery disconnect switch and intercell connectors.

    a. Factory assembled in an isolated compartment of UPS cabinet.
    b. Mount on [**two-tier,**][**three-tier,**] acid-resistant, painted steel racks.
    c. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

D. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) must be designed and fabricated to withstand static and seismic forces.

2.15 BASIC BATTERY MONITORING

A. Basic Battery Monitoring: Continuous, real-time capture of battery performance data.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alber**]
2. [**APC by Schneider Electric**]
3. [**BTECH, Inc**]
4. [**Canara**]
5. [**Eaton**]
6. [**Liebert; Vertiv Holdings Co.**]
7. [**Midtronics, Inc**]
8. [**Power Systems Specialists, Inc.**]
9. [**Staco Energy Products Co.**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alber**]
2. [**APC by Schneider Electric**]
3. [**BTECH, Inc**]
4. [**Canara**]
5. [**Eaton**]
6. [**Liebert; Vertiv Holdings Co.**]
7. [**Midtronics, Inc**]
8. [**Power Systems Specialists, Inc.**]
9. [**Staco Energy Products Co.**]
10. <**Insert manufacturer's name**>

D. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 Ω.

E. Battery compartment high-temperature detector initiates an alarm when smoke or a temperature greater than **167 deg F (75 deg C)** occurs within the compartment.

F. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than **167 deg F (75 deg C)** occurs within the compartment.

G. Annunciation of Alarms: At UPS control panel and remotely.

2.16 ADDITIONAL BATTERY MONITORING

A. Monitoring features and components must include the following:

1. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
2. Connections for data transmission via TIA-485 link, [**and**][**network interface and**] external signal wiring to [**computer**][**electrical power monitoring and control equipment**]. External signal wiring and computer are not specified in this Section.
3. USB ports for printer and accessories.
4. PC-based software designed to store and analyze battery data, compile reports on individual-cell parameters and total battery performance trends, and provide data for scheduling and prioritizing battery maintenance.

B. Operation: Automatically measure and electronically record the following parameters on a routine

schedule and during battery discharge events. During discharge events, record measurements timed to nearest second; including measurements of the following parameters:

1. Total battery voltage and ambient temperature.
2. Individual-cell voltage, impedance, and temperature, and string current. During battery-discharging events such as utility outages, measures battery and cell voltages, battery string current and records values versus time to nearest second.
3. Individual-cell electrolyte levels.

2.17 BATTERY-CYCLE WARRANTY MONITORING

A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.

B. Operation: Automatically measure and record each discharge event, classify it according to duration category and total discharges in accordance with warranty criteria, and display remaining warranted battery life on front panel display.

C. Additional monitoring functions and features must include the following:

1. Measuring and Recording: Total voltage at battery terminal. Initiate an alarm for excursions outside the proper float-voltage level.
2. Monitoring: Ambient temperature at battery; initiate an alarm if temperature deviates from normally acceptable range.
3. Keypad on Device Front Panel: Provide access to monitored data using front panel display.
4. Alarm Contacts: Arrange to initiate [**local**][**remote**] alarm for [**battery discharge events**][**abnormal temperature**][**abnormal battery voltage or temperature**].
5. Memory: Store recorded data in nonvolatile electronic memory.
6. Ethernet Port: Permits downloading of data to a PC.

2.18 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures,[**diagrams,**][**schedules,**] and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for UPS.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Product Certificates: For each product, from manufacturer.
4. Sample Warranties: For manufacturer's special warranties.

B. Factory Tests:

1. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
2. Factory Tests and Inspections: Test and inspect UPS system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with NETA ATS before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

a. Factory test complete UPS system before shipment. Use [**actual batteries that are part of final installation**][**the same type of batteries that are part of final installation**][**simulated battery testing**]. Include the following:

1) Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2) Full-load test.
3) Transient-load response test.
4) Overload test.
5) Power failure test.

3. Nonconforming Work:

   a. Equipment that does not pass tests and inspections will be considered defective.

4. Factory Test Reports: Prepare and submit factory test and inspection reports. Include the following data:

   a. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
   b. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
   c. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify installation conditions are representative of the conditions used in the coordination studies for the electrical system. Provide fuse protection in accordance with Section 262813 "Fuses" if required for coordination with UPS overcurrent protective device requirements.

3.2 INSTALLATION

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
3. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems."
4. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18 inch (450 mm)** centers around the full perimeter of concrete base **6 inch (150 mm)** from the outer edge of the base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.

E. Connections: Interconnect system components. Make connections to supply and load circuits in accordance with manufacturer's wiring diagrams unless otherwise indicated. Apply oxide inhibitor on battery terminals.

3.3 GROUNDING

A. Separately Derived Systems:

1. If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
2. If part of a listed power supply for a data-processing room, comply with manufacturer's published instructions that include grounding requirements in excess of NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each battery cell individually.

3.5 BATTERY EQUALIZATION

A. Equalize charging of battery cells in accordance with manufacturer's published instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Inspect interiors of enclosures, including the following:

    a. Inspect anchorage, alignment, grounding, and required clearances.
    b. Component type and labeling verification.
    c. Ratings of installed components.

2. Test electrical and mechanical interlock systems for correct operation and sequencing.
3. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of low-resistance ohmmeter in accordance with Section 7.22.2.2 of NETA ATS.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published instructions or Table 100.12 of NETA ATS.
    c. Perform thermographic survey in accordance with Section 9 of NETA ATS.

4. Test static transfer from inverter to bypass and back. Use normal load, if possible.
5. Test DC undervoltage trip level on inverter input breaker. Set in accordance with manufacturer's published instructions.
6. Verify synchronizing indicators for static switch and bypass switches.
7. Test insulated-case and molded-case breakers.

    a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published instructions. In the absence of manufacturer's published instructions, use Table 100.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components, follow manufacturer's recommendation.
    c. Use primary current injection to determine long time and short time, ground fault, and instantaneous pickup, Use secondary current injection to test trip functions.
    d. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published instructions.
    e. Verify operation of charging mechanism.
    f. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.

8. Test automatic transfer switches.

    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Section 7.22.3.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.
    c. Perform a contact/pole-resistance test.
    d. Verify settings and operation of control devices.
    e. Calibrate and set all relays and timers in accordance with Section 7.9 of NETA ATS.
    f. Verify phase rotation, phasing, and synchronized operation as required by the application.
    g. Perform automatic transfer tests.

        1) Simulate loss of normal power.
        2) Return to normal power.

3) Simulate loss of emergency power.
4) Simulate all forms of single-phase conditions.

h. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Time delay on transfer.
3) Alternative source voltage-sensing and frequency-sensing relays.
4) Automatic transfer operation.
5) Interlocks and limit switch function.
6) Time delay and retransfer on normal power restoration.

9. Test direct current system's batteries.

a. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
b. [**Verify electrolyte level. Measure electrolyte level, specific gravity, and temperature.**]
c. Inspect spill containment installation. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
d. Verify all charger functions and alarms.
e. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
f. Perform a load test in accordance with manufacturer's published instructions or IEEE 450.
g. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
h. Test values.

1) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Charger float and equalize voltage levels must be in accordance with battery manufacturer's published instructions.
3) The results of charger functions and alarms must be in accordance with manufacturer's published instructions.
4) Cell voltages must be within 0.05 V of each other or in accordance with manufacturer's published instructions.
5) Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state.
6) Results of load tests must be in accordance with manufacturer's published instructions or IEEE 450.

10. Test communication of status and alarms to remote monitoring equipment.
11. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous [**six months**]<**Insert time**> in accordance with NIST standards.

a. Simulate malfunctions to verify protective device operation.
b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
c. Test harmonic content of input and output current at 25, 50, and 100 percent of rated loads.
d. Test output voltage under specified transient-load conditions.
e. Test efficiency at 50, 75, and 100 percent of rated loads.
f. Test remote status and alarm panel functions.
g. Test battery-monitoring system functions.

D. Seismic-restraint tests and inspections must include the following:

1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
2. Test mounting and anchorage devices in accordance with requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Nonconforming Work:

1. The UPS system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports. Include references to manufacturers' published instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.7 PERFORMANCE TESTING

A. Engage the services of a qualified power quality specialist to perform tests and activities indicated[**for each UPS system**].

B. Monitoring and Testing Schedule: Perform monitoring and testing in [**a single 10-day period**][**four 10-day periods, each in a different season of the year**]<**Insert period**>.

1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.

C. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments must provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments must monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments must be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:

1. Current: Each phase and neutral and grounding conductors.
2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
3. Frequency transients.
4. Voltage swells and sags.
5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
6. High-frequency noise.
7. Radio-frequency interference.
8. THD of the above currents and voltages.
9. Harmonic content of currents and voltages above.
10. Battery cell temperature during charging.
11. Ambient temperature.

D. Monitoring and Testing Procedures[**for Each Test Period**]:

1. Exploratory Period: For the first [**two**]<**Insert number**> days[**of the first scheduled monitoring and testing period**], make recordings at various circuit locations and with various parameter-

threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.

2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.

    a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.
    b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period in accordance with directions of Owner's power quality specialist.
    c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
    d. Using loads and devices available as part of the facility's installed systems and equipment[**and a temporarily connected portable generator set**], create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
    e. Using temporarily connected resistive/inductive load banks[**and a temporarily connected portable generator set**], create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
    f. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing; repeat appropriate monitoring and testing to verify success of corrective action.

E. Coordination with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this article.

1. Provide the temporary use of an appropriate PC and printer equipped with required connections and software for recording and printing if such units are not available on-site.
2. Coordinate printouts with recordings for monitoring performed in accordance with this article, and resolve and report any anomalies in and discrepancies between the two sets of records.

F. Monitoring and Testing Assistance by Contractor:

1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.
3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist must design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.
5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.

G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load

conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.

H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in [**each**]report:

1. Descriptions of corrective actions performed during monitoring and survey work and their results.
2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
5. Recommendations for operating, adjusting, or revising UPS controls.
6. Recommendations for alterations to the UPS installation.
7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
8. Recommendations for power distribution system revisions.
9. Recommendations for adjusting or revising electrical loads, their connections, or controls.

I. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.

END OF SECTION 26 35 33 00

Task	Specification	Specification Description
26 35 33 16	26 09 23 00	Electrical Power Monitoring
26 35 33 16	26 35 33 00	Power Factor Correction Equipment

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SECTION 26 36 00 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contactor-type automatic transfer switches.
2. Molded-case-type automatic transfer switches.
3. Nonautomatic transfer switches.
4. Transfer switch accessories.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Contactor-type automatic transfer switches.
2. Molded-case-type automatic transfer switches.
3. Nonautomatic transfer switches.
4. Transfer switch accessories.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, [**bypass/isolation switch,**]power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**manufacturer-authorized service representative**][**testing agency**].

B. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Features and operating sequences, both automatic and manual.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.

a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**12 months**][**18 months**][**Two years**]<**Insert time**> from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.

F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Short-time withstand capability for [**three**][**30**]<**Insert number**> cycles.

H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Service-Rated Transfer Switch:

1. Comply with UL 869A and UL 489.
2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
3. In systems with a neutral, the bonding connection shall be on the neutral bus.
4. Provide removable link for temporary separation of the service and load grounded conductors.
5. Surge Protective Device: Service rated.
6. Ground-Fault Protection: Comply with UL 1008 for [**normal bus**][**normal and alternative buses**].
7. Service Disconnecting Means: Externally operated, manual [**mechanically**][**electrically**] actuated.

L. Neutral Switching: Where four-pole switches are indicated, provide [**neutral pole switched simultaneously with phase poles**][**overlapping neutral contacts**].

M. Neutral Terminal: Solid and fully rated unless otherwise indicated.

N. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

O. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

P. Battery Charger: For generator starting batteries.

1. Float type, rated [**2**][**10**] A.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

Q. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

R. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable [**with printed**][**tape**][**shrinkable sleeve**] markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via [**rear**][**front**] access.

S. Enclosures: General-purpose NEMA 250, [**Type 1**][**Type 3R**][**Type 4X**][**Type 12**], complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Eaton**]
6. [**Generac**]
7. [**Hubbell Utility Solutions; Hubbell Incorporated**]
8. [**Kohler Power Systems**]
9. [**Rolls-Royce Solutions America Inc.**]
10. [**Russelectric, Inc**]
11. [**Vertiv; Vertiv Holdings Co.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**ASCO Power Technologies**]
3. [**Caterpillar, Inc.; Electric Power Division**]
4. [**Cummins Power Generation**]
5. [**Eaton**]
6. [**Generac**]
7. [**Hubbell Utility Solutions; Hubbell Incorporated**]
8. [**Kohler Power Systems**]
9. [**Rolls-Royce Solutions America Inc.**]
10. [**Russelectric, Inc**]
11. [**Vertiv; Vertiv Holdings Co.**]
12. <**Insert manufacturer's name**>

C. Comply with Level 1 equipment according to NFPA 110.

D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**].
6. Main and Neutral Lugs: [**Compression**][**Mechanical**] type.
7. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.
10. <**Insert features**>.

E. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

F. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
3. Fully automatic break-before-make operation with center off position.
4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.

G. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.

1. Fully automatic make-before-break operation when transferring between two available power sources.

2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
    c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

H. Manual Switch Operation, Load-Breaking: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

I. Manual Switch Operation, Non-Load-Breaking: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

J. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

K. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

L. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

M. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal [**and Alternate**]Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:

    a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
    b. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

N. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 MOLDED-CASE-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Caterpillar, Inc.; Electric Power Division**]

3. [**Cummins Power Generation**]
4. [**Eaton**]
5. [**Emerson Electric Co., Automation Solutions**]
6. [**Generac**]
7. [**Kohler Power Systems**]
8. [**Lake Shore Electric Corporation**]
9. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Caterpillar, Inc.; Electric Power Division**]
3. [**Cummins Power Generation**]
4. [**Eaton**]
5. [**Emerson Electric Co., Automation Solutions**]
6. [**Generac**]
7. [**Kohler Power Systems**]
8. [**Lake Shore Electric Corporation**]
9. <**Insert manufacturer's name**>

C. Comply with Level 1 equipment according to NFPA 110.

D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using contactor-based components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**].
6. Main and Neutral Lugs: [**Compression**][**Mechanical**] type.
7. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.
10. <**Insert features**>.

E. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

F. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
3. Fully automatic break-before-make operation with center off position.
4. Fully automatic break-before-make operation with transfer when two sources have near zero

phase difference.

G. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.

1. Fully automatic make-before-break operation when transferring between two available power sources.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
    c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

H. Manual Switch Operation, Load-Breaking: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

I. Manual Switch Operation, Non-Load-Breaking: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

J. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

K. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

L. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

M. Transfer Switches Based on Molded-Case-Switch Components: Comply with UL 489 and UL 869A.

N. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal [**and Alternative**]Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:

    a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
    b. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

O. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.4 NONAUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASCO Power Technologies**]
2. [**Caterpillar, Inc.; Electric Power Division**]
3. [**Cummins Power Generation**]
4. [**Eaton**]
5. [**ESL Power Systems, Inc.**]
6. [**Russelectric, Inc**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ASCO Power Technologies**]
2. [**Caterpillar, Inc.; Electric Power Division**]
3. [**Cummins Power Generation**]
4. [**Eaton**]
5. [**ESL Power Systems, Inc.**]
6. [**Russelectric, Inc**]
7. <**Insert manufacturer's name**>

C. Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

D. Manual and Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.

E. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

F. Pilot Lights: Indicate source to which load is connected.

G. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Alternative Source Available."

H. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

I. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: [**Tin-plated aluminum**][**Hard-drawn copper, 98 percent conductivity**].

5. Main and Neutral Lugs: [**Compression**][**Mechanical**] type.
6. Ground Lugs and Bus-Configured Terminators: [**Compression**][**Mechanical**] type.
7. Ground bar.
8. Connectors shall be marked for conductor size and type according to UL 1008.
9. <**Insert features**>.

2.5 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

    a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
    b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
    c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
    d. Transition:

        1) Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
        2) Provide [**open**][**closed**]-transition operation when transferring between power sources.

    e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
    f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
    g. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
    h. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.
    i. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
    j. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.

2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:

    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of communication link.

4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

    a. Indicating Lights: Grouped for each transfer switch monitored.
    b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
    d. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Remote Annunciator and Control System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:

    a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Indication of switch position.
    c. Indication of switch in test mode.
    d. Indication of failure of digital communication link.
    e. Key-switch or user-code access to control functions of panel.
    f. Control of switch-test initiation.
    g. Control of switch operation in either direction.
    h. Control of time-delay bypass for transfer to normal source.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

    a. Controls and indicating lights grouped together for each transfer switch.
    b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
    c. Digital Communication Capability: Matched to that of transfer switches supervised.
    d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for [**emergency**][**legally required**] systems. Include results of test for the following conditions:

    a. Overvoltage.
    b. Undervoltage.
    c. Loss of supply voltage.
    d. Reduction of supply voltage.
    e. Alternative supply voltage or frequency is at minimum acceptable values.
    f. Temperature rise.
    g. Dielectric voltage-withstand; before and after short-circuit test.
    h. Overload.
    i. Contact opening.
    j. Endurance.
    k. Short circuit.
    l. Short-time current capability.
    m. Receptacle withstand capability.
    n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, [**motor controls,**]control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

H. Route and brace conductors according to manufacturer's written instructions[.][**and Section 260529 "Hangers and Supports for Electrical Systems."**] Do not obscure manufacturer's markings and labels.

I. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

J. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than **18 inches (457 mm)** in length.

3.3 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:

1. Owner will engage qualified testing agency to administer and perform tests and inspections.
2. Engage qualified testing agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify that the unit is clean.
    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Verify that manual transfer warnings are attached and visible.
    g. Verify tightness of all control connections.
    h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

    i. Perform manual transfer operation.
    j. Verify positive mechanical interlocking between normal and alternate sources.
    k. Perform visual and mechanical inspection of surge arresters.

l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery

from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00 00

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Task	Specification	Specification Description
26 36 13 00	26 28 16 00	Enclosed Switches And Circuit Breakers
26 36 13 00	26 36 00 00	Transfer Switches
26 36 23 00	26 28 16 00	Enclosed Switches And Circuit Breakers
26 36 23 00	26 36 00 00	Transfer Switches

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SECTION 26 43 13 00 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type 1 surge protective devices (SPDs).
2. Type 2 surge protective devices (SPDs).
3. Type 3, Type 4, and Type 5 surge protective devices (SPDs).
4. Enclosures.
5. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
4. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
5. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.2 DEFINITIONS

A. In: Nominal discharge current.

B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.

C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.

D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).

E. SCCR: Short-circuit current rating.

F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

H. Type 3 SPDs: Point of utilization SPDs.

I. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.

J. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.

K. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPDs.
b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

1) Tested values for VPRs.
2) In ratings.
3) MCOV, type designations.
4) OCPD requirements.
5) Manufacturer's model number.
6) System voltage.
7) Modes of protection.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.5 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: [**Five**]<**Insert number**> year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: [**10**]<**Insert number**> year(s) from date of Substantial Completion, for materials only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Citel, Inc.**]
5. [**DITEK Surge Protection**]
6. [**Eaton**]
7. [**Intermatic, Inc**]
8. [**Leviton Manufacturing Co., Inc.**]
9. [**Liebert; Vertiv Holdings Co.**]
10. [**Mersen USA**]
11. [**Schneider Electric USA, Inc.**]
12. [**Siemens Industry, Inc., Energy Management Division**]
13. [**SSI, an ILSCO Company**]
14. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Citel, Inc.**]
5. [**DITEK Surge Protection**]
6. [**Eaton**]
7. [**Intermatic, Inc**]
8. [**Leviton Manufacturing Co., Inc.**]
9. [**Liebert; Vertiv Holdings Co.**]
10. [**Mersen USA**]
11. [**Schneider Electric USA, Inc.**]
12. [**Siemens Industry, Inc., Energy Management Division**]
13. [**SSI, an ILSCO Company**]
14. <**Insert manufacturer's name**>

C. Source Limitations: Obtain devices from single source from single manufacturer.

D. General Characteristics:

1. Reference Standards: UL 1449, Type 1.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than [**160**][**200**][**240**][**320**]<**Insert value**> kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with [**480Y/277 V**][**208Y/120 V**], three-phase, four-wire circuits must not exceed the following:

a. Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
b. Line to Line: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**].

5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

a. Line to Neutral: 700 V.
b. Line to Line: 1200 V.

6. SCCR: Not less than [**100**][**200**]<**Insert value**> kA.
7. In Rating: 20 kA.

E. Options:

1. Include integral disconnect switch.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at [**2 A and 24 V(ac)**]<**Insert values**> for remote monitoring of protection status.
6. Include surge counter.

2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Citel, Inc.**]
5. [**Eaton**]
6. [**Intermatic, Inc**]
7. [**Leviton Manufacturing Co., Inc.**]
8. [**Liebert; Vertiv Holdings Co.**]
9. [**Mersen USA**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Energy Management Division**]
12. [**SSI, an ILSCO Company**]
13. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Electrification Business**]
2. [**Advanced Protection Technologies Inc. (APT)**]
3. [**ALLTEC LLC**]
4. [**Citel, Inc.**]
5. [**Eaton**]
6. [**Intermatic, Inc**]
7. [**Leviton Manufacturing Co., Inc.**]

8. [**Liebert; Vertiv Holdings Co.**]
9. [**Mersen USA**]
10. [**Schneider Electric USA, Inc.**]
11. [**Siemens Industry, Inc., Energy Management Division**]
12. [**SSI, an ILSCO Company**]
13. <**Insert manufacturer's name**>

C. Source Limitations: Obtain devices from single source from single manufacturer.

D. General Characteristics:

1. Reference Standards: UL 1449, Type 2[**; UL 1283**].
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than [**100**][**150**]<**Insert value**> kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with [**480Y/277 V**][**208Y/120 V**], three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
    b. Line to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
    c. Neutral to Ground: [**1200 V for 480Y/277 V**][**700 V for 208Y/120 V**].
    d. Line to Line: [**2000 V for 480Y/277 V**][**1200 V for 208Y/120 V**].

5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.
    b. Line to Ground: 700 V.
    c. Neutral to Ground: 700 V.
    d. Line to Line: 1200 V.

6. SCCR: Equal or exceed [**100**][**200**]<**Insert value**> kA.
7. In Rating: [**20**][**10**] kA.

E. Options:

1. Include LED indicator lights for power and protection status.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include NEMA ICS 5, dry Form C contacts rated at [**2 A and 24 V(ac)**]<**Insert values**> for remote monitoring of protection status.
4. Include surge counter.

2.3 TYPE 3, TYPE 4, AND TYPE 5 SURGE PROTECTIVE DEVICES (SPDs)

A. Type 3, Type 4, and Type 5 SPDs are not approved for field installation.[**See "Related Requirements" Paragraph in "Summary" Article for products with manufacturer-installed Type 3, Type 4, and Type 5 SPDs.**]

2.4 ENCLOSURES

A. Indoor Enclosures: Type 1.

B. Outdoor Enclosures: [**Type 3R**][**Type 4X**].

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Do not exceed manufacturer's recommended lead length.
3. Do not bond neutral and ground.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

B. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

C. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and

inspections.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 26 43 13 00

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SECTION 26 50 00 00 - LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Luminaires.
2. Luminaire fittings.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 260519 "Low-Voltage Electrical Power Conductors and Cables"**][**and**][**Section 260523 "Control-Voltage Electrical Power Cables"**] specifies wiring connections installed by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies channel and angle supports installed by this Section.
6. Section 260546 "Poles for Electrical Systems" specifies lighting standards, utility poles, and accessories referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
8. Section 260923 "Lighting Control Devices" specifies automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors installed by this Section.
9. Section 260936 "Modular Dimming Controls" specifies architectural dimming systems with dimming installed by this Section.
10. Section 260943.16 "Addressable Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" specify manual or programmable control systems with low-voltage control wiring or data communication circuits installed by this Section.

1.2 DEFINITIONS

A. BUG Rating: Backlight, uplight, and glare rating for light pollution from exterior luminaires.

B. Correlated Color Temperature (CCT): The absolute temperature (in kelvins) of a blackbody whose chromaticity (color quality) most nearly resembles that of the light source.

C. Color Rendering Index (CRI): The measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference light source. The lower the CRI of a light source, the more difficult it is to identify colors and stripes on electronic components and wiring.

D. IDA: International Dark-Sky Association.

E. IES: Illuminating Engineering Society.

F. LPD: Lighting power density.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Luminaires: Include the following additional information:

a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.

b. Product Certificates: Include product certificates stating compliance with standards listed below, signed by manufacturer or fabricator.

1) Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with current accreditation under National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
2) Testing Agency Certified Data: For luminaires indicated on Lighting Fixture Schedule on the Drawings, photometric data certified by qualified independent testing laboratory. Photometric data for remaining luminaires must be certified by manufacturer.
3) Air and Thermal Performance Data: For air-handling luminaires, include data required in [**Section 233713.13 "Air Diffusers."**][**Section 233713.23 "Registers and Grilles."**][**Section 233713.43 "Security Registers and Grilles."**]
4) Sound Performance Data: For air-handling luminaires, indicate sound power level and sound transmission class in test reports certified in accordance with standards specified in [**Section 233713.13 "Air Diffusers."**][**Section 233713.23 "Registers and Grilles."**][**Section 233713.43 "Security Registers and Grilles."**]

c. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
d. Include operating characteristics, electrical characteristics, and furnished accessories.
e. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on the Drawings.
f. Include battery and charger data for emergency lighting units.
g. Include ballast factor.
h. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
i. Include photometric data and adjustment factors obtained from qualified laboratory tests.
j. Include manufacturer's sample warranty language.
k. <**Insert requirements**>.

2. Luminaire Fittings: Include the following additional information:

a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.

b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
c. Include operating characteristics, electrical characteristics, and furnished accessories.
d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on the Drawings.
e. Include manufacturer's sample warranty language.
f. <**Insert requirements**>.

B. Samples:

1. Luminaires: One for each kind of luminaire with specified rating, size, finish, color, and texture.
2. Luminaire Fittings: One for each kind of luminaire fitting with specified rating, size, finish, color, and texture.

C. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents for Custom Luminaires:

a. Include plans, elevations, sections, and mounting and attachment details.
b. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Include diagrams for power, signal, and control wiring.

D. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.
2. ASHRAE/IES 90.1 LPD Compliance Documentation: Prepare plans and calculations demonstrating that as-constructed lighting power density complies with mandatory provisions of ASHRAE/IES 90.1 and that as-constructed lighting, including daylighting and controls, improves on baseline energy performance. If included with Project, indicate locations of energy meters for lighting loads.

E. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Extra stock material.

1.7 MOCKUPS

A. Provide mockups as indicated on the Drawings to verify selections made under Sample submittals and to set quality standards for materials and execution.

1. Build mockup of luminaires in room or space, complete with power and control connections.
2. Obtain Architect's approval of mockups before starting installation of related Work on the Project.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Maintain mockups during construction in undisturbed condition as standard for judging the completed Work.
5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Luminaire Photometric Testing Laboratory: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" accredited under NIST HB 150-1, and complying with applicable IES testing standards.

E. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect exposed surface finishes on lighting equipment by applying strippable, temporary protective covering before shipping.

1.10 WARRANTY FOR LUMINAIRES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed luminaires perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that luminaires perform in accordance with specified requirements and agrees to provide repair or replacement of products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

1.11 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period for Li-ion Batteries: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
2. Follow-On Extended-Warranty Period for Li-ion Batteries: [**10**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
3. Initial Extended-Warranty Period for Ni-Cd Batteries: [**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
4. Follow-On Extended-Warranty Period for Ni-Cd Batteries: [**15**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 LUMINAIRES

A. Surface-Mounted Luminaire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Albeo; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   b. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   c. [**Amerlux**]
   d. [**Architectural Area Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   e. [**Atlas Lighting Products**]
   f. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   g. [**Cooper Lighting Solutions; Signify North America Corp.**]
   h. [**Deco Lighting**]
   i. [**Digital Lumens**]
   j. [**E-conolight**]
   k. [**Edison Price Lighting**]
   l. [**Elite Lighting Corporation**]
   m. [**Focal Point; Legrand North America, LLC**]
   n. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
   o. [**GE Lighting; a Savant Company**]
   p. [**H.E. Williams**]
   q. [**Howard Lighting Products**]
   r. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   s. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
   t. [**Lighting Services, Inc.**]
   u. [**Lightolier; brand of Signify North America Corp.**]
   v. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
   w. [**LMPG Inc.**]
   x. [**Luraline Lighting**]
   y. [**OSRAM SYLVANIA**]
   z. [**Philips; Signify North America; Signify Holding**]
   aa. [**Pure Lighting Manufacturing Ltd.**]
   bb. [**PureEdge Lighting**]
   cc. [**RAB Lighting**]
   dd. [**Selux Corporation**]
   ee. [**Specialty Lighting Industries, Inc.**]
   ff. [**Visa Lighting**]
   gg. [**West Durable Lighting**]
   hh. [**Zumtobel Lighting, Inc.; Zumtobel Group**]
   ii. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Albeo; brand of GE Current, a Daintree company; American Industrial Partners**

(AIP)]
b. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
c. [**Amerlux**]
d. [**Architectural Area Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
e. [**Atlas Lighting Products**]
f. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
g. [**Cooper Lighting Solutions; Signify North America Corp.**]
h. [**Deco Lighting**]
i. [**Digital Lumens**]
j. [**E-conolight**]
k. [**Edison Price Lighting**]
l. [**Elite Lighting Corporation**]
m. [**Focal Point; Legrand North America, LLC**]
n. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
o. [**GE Lighting; a Savant Company**]
p. [**H.E. Williams**]
q. [**Howard Lighting Products**]
r. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
s. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
t. [**Lighting Services, Inc.**]
u. [**Lightolier; brand of Signify North America Corp.**]
v. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
w. [**LMPG Inc.**]
x. [**Luraline Lighting**]
y. [**OSRAM SYLVANIA**]
z. [**Philips; Signify North America; Signify Holding**]
aa. [**Pure Lighting Manufacturing Ltd.**]
bb. [**PureEdge Lighting**]
cc. [**RAB Lighting**]
dd. [**Selux Corporation**]
ee. [**Specialty Lighting Industries, Inc.**]
ff. [**Visa Lighting**]
gg. [**West Durable Lighting**]
hh. [**Zumtobel Lighting, Inc.; Zumtobel Group**]
ii. <**Insert manufacturer's name**>

3. Source Limitations: [**Obtain products for this luminaire type from single manufacturer**][**Bin LEDs for this luminaire type within three-step MacAdam Ellipse to ensure consistent chromaticity for all luminaires of this type**].
4. Listing Criteria:

    a. Incandescent Luminaires: UL CCN IEZR; including UL 1598.
    b. LED Luminaires: UL CCN IFAM; including UL 1598.
    c. Outdoor Canopy Luminaires: UL CCN IFAW; including UL 1598.
    d. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Luminaire Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

    a. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from

enclosure.

b. Nominal Operating Voltage: [**120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**480 V(ac)**][**120/60 V(ac)**][**12 V(dc)**][**24 V(dc)**].

c. Nominal Luminaire Operating Power Rating: [**Less than 20 W**][**20 to 60 W**][**70 to 150 W**][**150 to 300 W**][**Greater than 300 W**]<**Insert basis-of-design product's rated wattage**>.

d. CRI: [**80+**][**90+**].

e. Ballast or Driver Location: [**Internal**][**Remote**][**Self-ballasted lamp**].

f. Materials:

1) Enclosure: [**ASTM B209/B209M extruded-aluminum**][**ASTM A36/A36M carbon structural steel**][**ASTM A568/A568M sheet steel**][**ASTM A240/A240M manufacturer's standard stainless steel**][**ASTM A653/A653M galvanized-steel**] housing and heat sink; free of sharp edges and burrs.

2) Enclosure Ingress Protection Rating: [**UL 50E Type 1 or IEC 60529 IP20**][**UL 50E Type 3R or IEC 60529 IP24**][**UL 50E Type 4X or IEC 60529 IP65**][**UL 50E Type 12 or IEC 60529 IP54**].

3) Lenses, Diffusers, and Globes:

a) [**Fixed**][**Adjustable**] lens.
b) [**Spot**][**Medium**][**Wide**] light distribution.
c) [**Tempered Fresnel annealed crystal glass**][**Prismatic annealed crystal glass**][**Diffuse annealed crystal glass**][**Clear annealed crystal glass**][**Prismatic acrylic**][**Clear, heat- and UV-stabilized virgin acrylic plastic**]<**Insert material**>.
d) Lens Thickness: Not less than **0.125 inch (3 mm)** unless otherwise indicated.
e) Distribution: [**Type I**][**Type II**][**Type III**][**Type IV**][**Type V**].

4) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

g. Incandescent Luminaires (UL CCN IEZR):

1) Lamp Base Size: [**Candelabra (E12)**][**Intermediate (E17)**][**Medium (E26 or E27)**][**Mogul (E39)**].

2) Lamp Shape and Optics: [**Arbitrary Spherical (A)**][**Bulged (B)**][**Bulged Reflector (BR)**][**Candelabra (C)**][**Candelabra Angular (CA)**][**Flambeau (F)**][**Globe (G)**][**Prismatic Aluminized Reflector (PAR)**][**Pear Shaped (PS)**][**Specialty (S)**][**Reflector (R)**][**Tube (T)**].

h. LED Luminaires (UL CCN IFAM):

1) Output Intensity: Not less than [**250 lm**][**575 lm**][**750 lm**][**1000 lm**][**1500 lm**][**2000 lm**][**3000 lm**][**5000 lm**][**10 000 lm**]<**Insert lumens**>.

2) Efficacy: Not less than [**75 lm/W**][**80 lm/W**][**85 lm/W**]<**Insert lm/W**>.

3) Rated Life: [**35 000**][**50 000**]<**Insert number**> hours to L70.

4) CCT: [**2000 K**][**2700-2200 K (flame)**][**Three-step selectable 2700-2500-2200 K**][**2700 K**][**3000 K**][**3500 K**][**4000 K**][**5000 K**][**6500 K**][**Five-step selectable 3000-6500 K**][**Three-step selectable 3000-4000-5000 K**]<**Insert kelvins**>.

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.

b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and**

Design Lights Consortium].

c. Backlight, Uplight, and Glare (BUG) Ratings: Exterior luminaire complies with IES LP-11-recommended BUG ratings at luminaire's intended location.

d. IDA/IES Five Principles Ready:

1) Exterior luminaire is adjustable to illuminate only to extent necessary for its intended purpose.
2) Exterior luminaire is aimable.
3) Exterior luminaire is dimmable.
4) Exterior luminaire is controllable to turn on only when needed.
5) Exterior luminaire has warm color temperature.

e. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.

f. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.

g. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.

h. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

i. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Hardware: [**Ceiling-mounted**][**Pendant-mounted**][**Wall-mounted**][**Building-mounted**][**Pole-mounted**]<**Insert desired mounting hardware**>; with [**integral mounting provisions**][**extruded-aluminum**][**stainless steel**]<**Insert material**>[**rectangular arm,**][**round arm,**][**11 inch (280 mm) in length**][**13 inch (330 mm) in length**].

b. Mounting Height: <**Insert height of luminaire from finished grade or floor**>.

c. Bollard:

1) Shape: [**Round**][**Square**][**Hexagonal**][**Fluted**]<**Insert shape or feature**>.
2) Height from Finished Grade: [**24 inch (610 mm)**][**30 inch (762 mm)**][**36 inch (900 mm)**]<**Insert value**>.
3) Overall Height: [**30 inch (762 mm)**][**36 inch (900 mm)**]<**Insert value**>.
4) Diameter: [**6 inch (150 mm)**]<**Insert value**>.
5) Bollard Mounting: [**Three-point cast-aluminum base**]<**Insert mounting provisions**>.

d. Decorative Post Top: [**Arm mounted**][**Tenon mounted**][**Ring mounted**].

e. Roadway Pole: [**Arm mounted**][**Tenon mounted**][**Ring mounted**].

f. Finishes:

1) Enclosure: [**Clear**]<**Insert color**>[**anodized**][**powder-coat**][**painted**] finish.
2) Reflector: [**Aluminum**]<**Insert material finish**>.
3) Reflecting surfaces must have minimum reflectance as follows, unless otherwise indicated:

a) White Surfaces: 85 percent.
b) Specular Surfaces: 83 percent.
c) Diffusing Specular Surfaces: 75 percent.

g. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

1) Finish designations prefixed by AA comply with system established by Aluminum Association for designating aluminum finishes.
2) Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3) Class I, Clear-Anodic Finish: AA-M32C22A41, complying with AAMA 611.

a) Mechanical Finish: Medium satin.
b) Chemical Finish: Etched, medium matte.
c) Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker.

4) Class I, Color-Anodic Finish: AA-M32C22A42/A44, complying with AAMA 611.

a) Mechanical Finish: Medium satin.
b) Chemical Finish: Etched, medium matte.
c) Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker).

5) Color: [**Light bronze**][**Medium bronze**][**Dark bronze**][**Black**]<**Insert color**>.

h. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
3) Color: [**As selected from manufacturer's standard catalog of colors**][**As selected by Architect from manufacturer's full range**][**Match color sample provided by Architect**].

i. Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.
j. Dimmable from 100 percent to zero percent of maximum light output.
k. EMI Filters: Factory installed to suppress conducted EMI in accordance with MIL-STD-461E. Fabricate luminaires with one filter on each ballast or driver requiring filter.
l. Stainless steel latches.
m. Integral pressure equalizer.
n. Photoelectric Switch: Factory-mounted integral to luminaire; listed and labeled in accordance with UL CCN WJFX, including UL 773, or in accordance with UL CCN WJCT, including UL 773A.

1) Contact Relays: Factory mounted, single throw, designed to fail in on position, and factory set to turn light unit on at **1.5 to 3 fc (15 to 30 lx)** and off at **4.5 to 10 fc (45 to 100 lx)** with 15 s minimum time delay.[**Relay must have directional lens in front of photocell to prevent artificial light sources from causing false turn-off.**]

a) Relay with locking-type receptacle must comply with NEMA C136.10.
b) Adjustable window slide for adjusting on-off set points.

9. Installation Markings:

   a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
   b. All Luminaires (UL CCN HYXT):

      1) "DRY LOCATIONS ONLY."
      2) "SUITABLE FOR DAMP LOCATIONS."
      3) "SUITABLE FOR WET LOCATIONS."
      4) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."
      5) "SUITABLE FOR GROUND-MOUNTED RECESSED."
      6) "LIMIT RANGE OF ADJUSTMENT TO <**Insert instruction**>."
      7) "COVERED CEILING MOUNT ONLY."
      8) "WALL MOUNT ONLY"
      9) "FOR CEILING MOUNTING ONLY."
      10) Marked with mounting orientation, such as "THIS END UP."
      11) "SUITABLE FOR AIR-HANDLING USE."
      12) "VENTILATING OR COOLING AIR ONLY."
      13) "ONLY FOR USE IN CEILING PLENUM OF NONCOMBUSTIBLE CONSTRUCTION OR WITH AIR-HANDLING PARTS THAT COVER VENT OPENINGS."
      14) "INSTALL ONLY IN ENVIRONMENTAL AIR-HANDLING SPACES WHERE A COMPLETE METAL ENCLOSED WIRING SYSTEM IS PROVIDED."
      15) "MIN [**75**□][**90**□][**150**□][**200**□][**250**□] SUPPLY CONDUCTORS."
      16) "NOT FOR USE IN DWELLING."
      17) "SUITABLE FOR USE AS RACEWAY."
      18) "60 Hz" or "AC ONLY."
      19) Marked to identify voltage supply or type of branch circuit or both.

   c. Incandescent Luminaires (UL CCN IEZR):

      1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."
      2) "PUSH CONDUCTORS INTO JUNCTION BOX."
      3) "SUITABLE FOR UNDER-CABINET MOUNT."
      4) "SUITABLE FOR CONTINUOUS ROW MOUNTING."
      5) "THIS LUMINAIRE MUST BE MOUNTED OR SUPPORTED INDEPENDENTLY OF AN OUTLET BOX."

   d. LED Luminaires (UL CCN IFAM):

      1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."
      2) "PUSH CONDUCTORS INTO JUNCTION BOX."
      3) "WALL MOUNT ONLY."
      4) "NONCOMBUSTIBLE SURFACE ONLY."
      5) "SUITABLE FOR UNDER-CABINET MOUNT."
      6) "SUITABLE FOR CONTINUOUS ROW MOUNTING."
      7) "THIS LUMINAIRE MUST BE MOUNTED OR SUPPORTED INDEPENDENTLY OF AN OUTLET BOX."

   e. Outdoor Canopy Luminaires (UL CCN IFAW):

      1) "CANOPY LUMINAIRE - NOT THERMALLY PROTECTED."
      2) "FOR COVERED CEILING MOUNT ONLY."

3) "OPEN CEILING MOUNT ONLY."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

    a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
    b. Component Importance Factor (Ip): [**1.0**][**1.5**].
    c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
    d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
    e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

B. Recessed Luminaire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Albeo; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    b. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    c. [**Amerlux**]
    d. [**Axis Lighting, Inc.**]
    e. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    f. [**Cooper Lighting Solutions; Signify North America Corp.**]
    g. [**Digital Lumens**]
    h. [**Edison Price Lighting**]
    i. [**Elite Lighting Corporation**]
    j. [**Focal Point; Legrand North America, LLC**]
    k. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
    l. [**GE Lighting; a Savant Company**]
    m. [**Lighting Services, Inc.**]
    n. [**Lightolier; brand of Signify North America Corp.**]
    o. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
    p. [**LMPG Inc.**]
    q. [**OSRAM SYLVANIA**]
    r. [**PureEdge Lighting**]
    s. [**RAB Lighting**]
    t. [**Selux Corporation**]
    u. [**Specialty Lighting Industries, Inc.**]
    v. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Albeo; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    b. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
    c. [**Amerlux**]

d. [**Axis Lighting, Inc.**]
e. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
f. [**Cooper Lighting Solutions; Signify North America Corp.**]
g. [**Digital Lumens**]
h. [**Edison Price Lighting**]
i. [**Elite Lighting Corporation**]
j. [**Focal Point; Legrand North America, LLC**]
k. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
l. [**GE Lighting; a Savant Company**]
m. [**Lighting Services, Inc.**]
n. [**Lightolier; brand of Signify North America Corp.**]
o. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
p. [**LMPG Inc.**]
q. [**OSRAM SYLVANIA**]
r. [**PureEdge Lighting**]
s. [**RAB Lighting**]
t. [**Selux Corporation**]
u. [**Specialty Lighting Industries, Inc.**]
v. <**Insert manufacturer's name**>

3. Source Limitations: [**Obtain products for this luminaire type from single manufacturer**][**Bin LEDs for this luminaire type within three-step MacAdam Ellipse to ensure consistent chromaticity for all luminaires of this type**].
4. Listing Criteria:

   a. Incandescent Luminaires: UL CCN IEZX; including UL 1598[**.**][**, and "Chicago Electrical Code."**]
   b. LED Luminaires: UL CCN IFAO; including UL 1598[**, and "Chicago Electrical Code."**]
   c. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Luminaire Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

   a. Ceiling Compatibility: NEMA LE 4.
   b. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.
   c. Nominal Operating Voltage: [**120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**12 V(dc)**][**24 V(dc)**].
   d. Nominal Luminaire Operating Power Rating: [**Less than 20 W**][**20 to 60 W**]<**Insert basis-of-design product's rated wattage**>.
   e. CRI: [**80+**][**90+**].
   f. Ballast or Driver Location: [**Internal**][**Remote**][**Self-ballasted lamp**].
   g. Materials:

      1) Enclosure: [**ASTM B209/B209M extruded-aluminum**][**ASTM A36/A36M carbon structural steel**][**ASTM A568/A568M sheet steel**][**ASTM A240/A240M manufacturer's standard stainless steel**][**ASTM A653/A653M galvanized-steel**] housing and heat sink; free of sharp edges and burrs.
      2) Enclosure Ingress Protection Rating: [**UL 50E Type 1 or IEC 60529 IP20**][**UL 50E Type 3R or IEC 60529 IP24**][**UL 50E Type 4X or IEC 60529 IP65**][**UL 50E Type 12 or IEC 60529 IP54**].
      3) Lenses, Diffusers, and Globes:

         a) [**Fixed**][**Adjustable**] lens.

b) [**Spot**][**Medium**][**Wide**] light distribution.
c) [**Tempered Fresnel annealed crystal glass**][**Prismatic annealed crystal glass**][**Diffuse annealed crystal glass**][**Clear annealed crystal glass**][**Prismatic acrylic**][**Clear, heat- and UV-stabilized virgin acrylic plastic**]<**Insert material**>.
d) Lens Thickness: Not less than **0.125 inch (3 mm)** unless otherwise indicated.

4) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

h. Incandescent Luminaires (UL CCN IEZX):

1) Lamp Base Size: [**Candelabra (E12)**][**Intermediate (E17)**][**Medium (E26 or E27)**][**Mogul (E39)**].
2) Lamp Shape and Optics: [**Arbitrary Spherical (A)**][**Bulged (B)**][**Bulged Reflector (BR)**][**Candelabra (C)**][**Candelabra Angular (CA)**][**Flambeau (F)**][**Globe (G)**][**Prismatic Aluminized Reflector (PAR)**][**Pear Shaped (PS)**][**Specialty (S)**][**Reflector (R)**][**Tube (T)**].

i. LED Luminaires (UL CCN IFAO):

1) Output Intensity: Not less than [**250 lm**][**575 lm**][**750 lm**][**1000 lm**][**1500 lm**][**2000 lm**][**3000 lm**][**5000 lm**][**10 000 lm**]<**Insert lumens**>.
2) Efficacy: Not less than [**75 lm/W**][**80 lm/W**][**85 lm/W**]<**Insert lm/W**>.
3) Rated Life: [**35 000**][**50 000**]<**Insert number**> hours to L70.
4) CCT: [**2000 K**][**2700-2200 K (flame)**][**Three-step selectable 2700-2500-2200 K**][**2700 K**][**3000 K**][**3500 K**][**4000 K**][**5000 K**][**6500 K**][**Five-step selectable 3000-6500 K**][**Three-step selectable 3000-4000-5000 K**]<**Insert kelvins**>.

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and Design Lights Consortium**].
c. Backlight, Uplight, and Glare (BUG) Ratings: Exterior luminaire complies with IES LP-11-recommended BUG ratings at luminaire's intended location.
d. IDA/IES Five Principles Ready:

1) Exterior luminaire is adjustable to illuminate only to extent necessary for its intended purpose.
2) Exterior luminaire is aimable.
3) Exterior luminaire is dimmable.
4) Exterior luminaire is controllable to turn on only when needed.
5) Exterior luminaire has warm color temperature.

e. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
f. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
g. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
h. Third-Party Certification: Third-party certification, in accordance with multiple attribute

standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.

i. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

   a. Mounting Hardware: [**Ceiling-mounted**][**Wall-mounted**]<**Insert desired mounting hardware**>; include universal mounting bracket and integral junction box with conduit fittings.
   b. Finishes:

      1) Enclosure: [**Clear**]<**Insert color**>[**anodized**][**powder-coat**][**painted**] finish.
      2) Reflector: [**Aluminum**]<**Insert material finish**>.
      3) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

   c. Dimmable from 100 percent to zero percent of maximum light output.
   d. EMI Filters: Factory installed to suppress conducted EMI in accordance with MIL-STD-461E. Fabricate luminaires with one filter on each ballast or driver requiring filter.
   e. Stainless steel latches.
   f. Integral pressure equalizer.

9. Installation Markings:

   a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
   b. All Luminaires (UL CCN HYXT):

      1) "DRY LOCATIONS ONLY."
      2) "SUITABLE FOR DAMP LOCATIONS."
      3) "SUITABLE FOR WET LOCATIONS."
      4) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."
      5) "SUITABLE FOR GROUND-MOUNTED RECESSED."
      6) "LIMIT RANGE OF ADJUSTMENT TO <**Insert instruction**>."
      7) "COVERED CEILING MOUNT ONLY."
      8) "WALL MOUNT ONLY"
      9) "FOR CEILING MOUNTING ONLY."
      10) Marked with mounting orientation, such as "THIS END UP."
      11) "SUITABLE FOR AIR-HANDLING USE."
      12) "VENTILATING OR COOLING AIR ONLY."
      13) "ONLY FOR USE IN CEILING PLENUM OF NONCOMBUSTIBLE CONSTRUCTION OR WITH AIR-HANDLING PARTS THAT COVER VENT OPENINGS."
      14) "INSTALL ONLY IN ENVIRONMENTAL AIR-HANDLING SPACES WHERE A COMPLETE METAL ENCLOSED WIRING SYSTEM IS PROVIDED."
      15) "MIN [**75**□][**90**□][**150**□][**200**□][**250**□] SUPPLY CONDUCTORS."
      16) "NOT FOR USE IN DWELLING."
      17) "SUITABLE FOR USE AS RACEWAY."
      18) "60 Hz" or "AC ONLY."
      19) Marked to identify voltage supply or type of branch circuit, or both.

   c. Incandescent Luminaires (UL CCN IEZX):

      1) "TYPE IC LUMINAIRE."

2) "TYPE NON-IC LUMINAIRE."
3) "INHERENTLY PROTECTED LUMINAIRE."
4) "INSTALL IN BUILDINGS OF FIRE-RESISTANT CONSTRUCTION."
5) "INSTALL WITH MINIMUM SPACINGS BETWEEN A) CENTER-TO-CENTER OF ADJACENT LUMINAIRES: <**Insert distance**> INCHES; B) TOP OF LUMINAIRE AND AN OVERHEAD BUILDING MEMBER: <**Insert distance**> INCHES; AND C) LUMINAIRE CENTER-TO-SIDE OF BUILDING MEMBER: <**Insert distance**> INCHES."
6) "FOR USE IN CONCRETE ONLY."
7) "SUITABLE FOR USE IN POURED CONCRETE."
8) "SUITABLE FOR SUSPENDED CEILING."
9) "SUITABLE FOR GROUND-MOUNTED RECESSED."
10) "BLINKING LIGHT OF THIS THERMALLY PROTECTED LUMINAIRE MAY INDICATE OVERHEATING."
11) "MAXIMUM OF <**Insert size**> AWG BRANCH CIRCUIT CONDUCTOR SUITABLE FOR <**Insert temperature**>□ PERMITTED IN BOX."
12) "FOR USE IN ONE- AND TWO-FAMILY DWELLINGS ONLY."
13) "FOR USE IN NON-FIRE-RATED INSTALLATIONS."
14) Provide correlating markings identifying matching housing, trim, rough-in section, and finishing section.
15) "Chicago Electrical Code" or "CCEA."

d. LED Luminaires (UL CCN IFAO):

1) "TYPE IC LUMINAIRE."
2) "TYPE NON-IC LUMINAIRE."
3) "INHERENTLY PROTECTED LUMINAIRE."
4) "INSTALL IN BUILDINGS OF FIRE-RESISTANT CONSTRUCTION."
5) "INSTALL WITH MINIMUM SPACINGS BETWEEN A) CENTER-TO-CENTER OF ADJACENT LUMINAIRES: <**Insert distance**> INCHES; B) TOP OF LUMINAIRE AND AN OVERHEAD BUILDING MEMBER: <**Insert distance**> INCHES; AND C) LUMINAIRE CENTER-TO-SIDE OF BUILDING MEMBER: <**Insert distance**> INCHES."
6) "FOR USE IN CONCRETE ONLY."
7) "SUITABLE FOR USE IN POURED CONCRETE."
8) "SUITABLE FOR SUSPENDED CEILING."
9) "SUITABLE FOR GROUND-MOUNTED RECESSED ONLY."
10) "SUITABLE FOR GROUND-MOUNTED RECESSED."
11) "BLINKING LIGHT OF THIS THERMALLY PROTECTED LUMINAIRE MAY INDICATE OVERHEATING."
12) "MAXIMUM OF <**Insert size**> AWG BRANCH CIRCUIT CONDUCTOR SUITABLE FOR <**Insert temperature**>□ PERMITTED IN BOX."
13) "ACCESS ABOVE CEILING REQUIRED."
14) "ACCESS BEHIND WALL REQUIRED."
15) "FOR USE IN ONE- AND TWO-FAMILY DWELLINGS ONLY."
16) "FOR USE IN NON-FIRE-RATED INSTALLATIONS."
17) Provide correlating markings identifying matching housing, trim, rough-in section, and finishing section.
18) "Chicago Electrical Code" or "CCEA."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational**

after seismic events]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

C. UL IFFR - Track-Lighting Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
b. [**Architectural Area Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
c. [**Axis Lighting, Inc.**]
d. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
e. [**Cooper Lighting Solutions; Signify North America Corp.**]
f. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
g. [**Edison Price Lighting**]
h. [**Elite Lighting Corporation**]
i. [**GE Lighting; a Savant Company**]
j. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
l. [**Lighting Services, Inc.**]
m. [**Lightolier; brand of Signify North America Corp.**]
n. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
o. [**Zumtobel Lighting, Inc.; Zumtobel Group**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alera Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
b. [**Architectural Area Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
c. [**Axis Lighting, Inc.**]
d. [**Columbia Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
e. [**Cooper Lighting Solutions; Signify North America Corp.**]
f. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
g. [**Edison Price Lighting**]
h. [**Elite Lighting Corporation**]
i. [**GE Lighting; a Savant Company**]
j. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
k. [**Kim Lighting; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
l. [**Lighting Services, Inc.**]

m. [**Lightolier; brand of Signify North America Corp.**]
n. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
o. [**Zumtobel Lighting, Inc.; Zumtobel Group**]
p. <**Insert manufacturer's name**>

3. Source Limitations: [**Obtain products for this luminaire type from single manufacturer**][**Bin LEDs for this luminaire type within three-step MacAdam Ellipse to ensure consistent chromaticity for all luminaires of this type**].
4. Listing Criteria:

a. Track Lighting: UL CCN IFFR; including UL 1574.
b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Product Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

a. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.
b. Nominal Luminaire Operating Voltage: [**120 V(ac)**][**240 V(ac)**][**277 V(ac)**][**12 V(dc)**][**24 V(dc)**].
c. Nominal Luminaire Operating Power Rating: [**Less than 20 W**][**20 to 60 W**][**70 to 150 W**][**150 to 300 W**][**Greater than 300 W**]<**Insert basis-of-design product's rated wattage**>.
d. CRI: [**80+**][**90+**].
e. Ballast or Driver Location: [**Internal**][**Remote**][**Self-ballasted lamp**].
f. Materials:

1) Enclosure: [**ASTM B209/B209M extruded-aluminum**][**ASTM A36/A36M carbon structural steel**][**ASTM A568/A568M sheet steel**][**ASTM A240/A240M manufacturer's standard stainless steel**][**ASTM A653/A653M galvanized-steel**] housing and heat sink; free of sharp edges and burrs.
2) Enclosure Ingress Protection Rating: UL 50E Type 1 or IEC 60529 IP20.
3) Lenses, Diffusers, and Globes:

a) [**Fixed**][**Adjustable**] lens.
b) [**Spot**][**Medium**][**Wide**] light distribution.
c) [**Tempered Fresnel annealed crystal glass**][**Prismatic annealed crystal glass**][**Diffuse annealed crystal glass**][**Clear annealed crystal glass**][**Prismatic acrylic**][**Clear, heat- and UV-stabilized virgin acrylic plastic**]<**Insert material**>.
d) Lens Thickness: Not less than **0.125 inch** **(3 mm)** unless otherwise indicated.

4) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

g. Incandescent Lamp Track-Lighting Luminaire:

1) Lamp Base Size: [**Candelabra (E12)**][**Intermediate (E17)**][**Medium (E26 or E27)**].
2) Lamp Shape and Optics: [**Arbitrary Spherical (A)**][**Bulged (B)**][**Bulged Reflector (BR)**][**Candelabra (C)**][**Candelabra Angular (CA)**][**Flambeau (F)**][**Globe (G)**][**Prismatic Aluminized Reflector (PAR)**][**Pear Shaped (PS)**][**Specialty (S)**][**Reflector (R)**][**Tube (T)**].

h. LED Track-Lighting Luminaires:

1) Output Intensity: Not less than [**250 lm**][**575 lm**][**750 lm**][**1000 lm**][**1500 lm**][**2000 lm**][**3000 lm**][**5000 lm**][**10 000 lm**]<**Insert lumens**>.
2) Efficacy: Not less than [**75 lm/W**][**80 lm/W**][**85 lm/W**]<**Insert lm/W**>.
3) Rated Life: [**35 000**][**50 000**]<**Insert number**> hours to L70.
4) CCT: [**2000 K**][**2700-2200 K (flame)**][**Three-step selectable 2700-2500-2200 K**][**2700 K**][**3000 K**][**3500 K**][**4000 K**][**5000 K**][**6500 K**][**Five-step selectable 3000-6500 K**][**Three-step selectable 3000-4000-5000 K**]<**Insert kelvins**>.

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and Design Lights Consortium**].
c. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Hardware: [**Ceiling-mounted**][**Pendant-mounted**][**Wall-mounted**]<**Insert desired mounting hardware**>; with integral mounting provisions.
b. Mounting Height: <**Insert height of luminaire from finished grade or floor**>.
c. Finishes:

1) Enclosure: [**Clear**]<**Insert color**>[**anodized**][**powder-coat**][**painted**] finish.
2) Reflector: [**Aluminum**]<**Insert material finish**>.
3) Visible variations in metal finishes[**outside range of approved Samples**] are unacceptable in adjoining components.

d. Dimmable from 100 percent to zero percent of maximum light output.

9. Installation Markings:

a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
b. All Luminaires (UL CCN HYXT):

1) "DRY LOCATIONS ONLY."
2) "SUITABLE FOR DAMP LOCATIONS."
3) "LIMIT RANGE OF ADJUSTMENT TO <**Insert instruction**>."
4) "MIN [**75**□][**90**□][**150**□][**200**□][**250**□] SUPPLY CONDUCTORS."
5) "60 Hz" or "AC ONLY."
6) Marked to identify voltage supply or type of branch circuit, or both.

c. Track Systems (UL CCN IFFR):

1) "FOR CLIP MOUNTING ONLY."
2) "DO NOT PENDANT MOUNT THIS TRACK SUCH AS BY STEMS OR WIRES."
3) "FOR USE IN <**Insert ceiling grid manufacturer and product**>."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

D. UL FTBR or FTBV - Emergency Lighting and Power Equipment :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amerlux**]
b. [**Cooper Lighting Solutions; Signify North America Corp.**]
c. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
d. [**Evenlite, Inc.**]
e. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
f. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
h. [**Philips; Signify North America; Signify Holding**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amerlux**]
b. [**Cooper Lighting Solutions; Signify North America Corp.**]
c. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
d. [**Evenlite, Inc.**]
e. [**GE Current, a Daintree company; American Industrial Partners (AIP)**]
f. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
g. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
h. [**Philips; Signify North America; Signify Holding**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria:

a. Emergency Lighting and Power: UL CCN FTBR or UL CCN FTBV; including UL 924, NFPA 101, and ICC IBC.

b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Product Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

a. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
b. Status and Test Indication: Visible and accessible without opening luminaire or entering ceiling space.

1) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
2) Test Push-Button: Push-to-test button in unit housing simulates loss of normal power and demonstrates unit operability.

c. Nominal Operating Voltage: [**120 V(ac)**][**277 V(ac)**][**6 V(dc)**][**9.6 V(dc)**][**12 V(dc)**][**24 V(dc)**].
d. Mounting: [**Ceiling**][**Wall**] with universal junction box adaptor.
e. Enclosure: UV stable thermoplastic housing rated for [**damp**][**wet**] locations.
f. Flame Rating: UL 94 [**5VA**][**5VB**][**V-0**][**V-1**][**V-2**][**HB**].
g. Light Source: [**One**][**Two**][**halogen lamp(s)**][**krypton lamp(s)**][**LED head(s)**].

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and Design Lights Consortium**].
c. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
e. Regional Materials (lgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Height: <**Insert height of luminaire from finished floor**>.
b. Internal-Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body[**and compatible with ballast or driver**].

1) Emergency Connection: Operate [**one**]<**Insert number**> lamp(s) continuously at an output of [**1100**]<**Insert value**> lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast or driver.
2) Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically

recharged and floated on charger.

3) Nightlight Connection: Operate lamp continuously at [**40**]<**Insert number**> percent of rated light output.
4) Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.

   a) Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

5) Battery Type: [**Ni-Cd**][**Li-ion**].
6) Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
7) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
8) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

c. External-Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1) Emergency Connection: Operate [**one**]<**Insert number**>[**incandescent**][**LED**] lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire[**ballast or driver**].
2) Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3) Nightlight Connection: Operate lamp in a remote luminaire continuously.
4) Battery Type: [**Ni-Cd**][**Li-ion**].
5) Charger: Fully automatic, solid-state, constant-current type.
6) Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by [**ballast or driver**][**emergency power unit**] manufacturer, whichever is less.
7) Test Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
10) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

9. Installation Markings:

   a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and

coating on factory-applied label that is visible when luminaire is open for relamping.

b. All Luminaires (UL CCN HYXT):

1) "SUITABLE FOR DAMP LOCATIONS."
2) "SUITABLE FOR WET LOCATIONS."
3) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."
4) Marked to identify voltage supply or type of branch circuit or both.

c. Emergency Lighting and Power Equipment (UL CCN FTBR):

1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."
2) "HAS CLASS 2 OUTPUTS."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

E. UL FWBO - Exit Fixture :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Amerlux**]
b. [**Cooper Lighting Solutions; Signify North America Corp.**]
c. [**Evenlite, Inc.**]
d. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**Philips; Signify North America; Signify Holding**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Amerlux**]
b. [**Cooper Lighting Solutions; Signify North America Corp.**]
c. [**Evenlite, Inc.**]
d. [**Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. [**Philips; Signify North America; Signify Holding**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria:

a. Exit Fixtures: UL CCN FWBO; including UL 924, NFPA 101[**, NFPA 5000**], and ICC IBC.
b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

5. Product Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

a. Nominal Operating Voltage: [**120 V(ac)**][**277 V(ac)**][**6 V(dc)**][**9.6 V(dc)**][**12 V(dc)**][**24 V(dc)**].
b. Light Source: LED; 50,000 hours minimum rated life.
c. Legend Color: [**Red**][**Green**].
d. Internal emergency power unit.
e. Battery Type: [**Ni-Cd**][**Li-ion**].
f. Master/Remote Sign Configurations:

1) Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in [**LED power supply**][**battery**] for power connection to remote unit.
2) Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

7. Sustainable Design Features:

a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
b. Energy Efficiency of LED Luminaires: Luminaire is certified by ENERGY STAR[**and Design Lights Consortium**].
c. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
d. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
e. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
f. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
g. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Other Available Features Required by the Project:

a. Mounting Height: <**Insert height of luminaire from finished floor**>.

9. Installation Markings:

a. All Luminaires (UL CCN HYXT):

1) "SUITABLE FOR DAMP LOCATIONS."
2) "SUITABLE FOR WET LOCATIONS."
3) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."
4) Marked to identify voltage supply or type of branch circuit or both.

b. Exit Fixtures (UL CCN FWBO):

1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."

10. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

F. UL FWBX - Self-Luminous or Photoluminescent Exit Sign :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Lighting Solutions; Signify North America Corp.**]
b. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
c. [**Evenlite, Inc.**]
d. [**Isolite Corporation**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cooper Lighting Solutions; Signify North America Corp.**]
b. [**Dual-Lite; brand of GE Current, a Daintree company; American Industrial Partners (AIP)**]
c. [**Evenlite, Inc.**]
d. [**Isolite Corporation**]
e. [**Lithonia Lighting; Acuity Brands Lighting, Inc.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: UL CCN FWBX; including UL 924, NFPA 101[**, NFPA 5000**], and ICC IBC.
5. Exit Sign Description: <**Insert description of desired shape and dimensional limitations**>.
6. Standard Features:

a. Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs must be guaranteed by manufacturer to maintain minimum brightness requirements in UL 924 for [**10**][**15**][**20**] years.
b. Use strontium oxide aluminate compound to store ambient light and release stored energy when light is removed. Include universal bracket for flush-ceiling, wall, or end mounting.

7. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

8. Installation Markings:

a. All Luminaires (UL CCN HYXT):

1) "SUITABLE FOR DAMP LOCATIONS."
2) "SUITABLE FOR WET LOCATIONS."
3) "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FT) OF THE GROUND" or "SUITABLE FOR FLOOR PROXIMITY INSTALLATION."

b. Self-Luminous and Photoluminescent Exit Signs (UL CCN FWBX):

1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <**Insert ambient temperature**>□."
2) Mark with minimum illumination level of necessary lighting type to achieve required visibility.

9. Seismic and Wind Performance: Installed product must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
b. Component Importance Factor (Ip): [**1.0**][**1.5**].
c. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
d. Component Response Modification Factor (Rp): [**1.5**][**2.5**]<**Insert value**>.
e. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.3 LUMINAIRE FITTINGS

A. Luminaire Support Accessories:

1. Standard Features:

a. Sized and rated for luminaire weight.
b. Capable of maintaining luminaire position after cleaning and relamping.
c. Capable of supporting luminaire without causing deflection of ceiling or wall.
d. Capable of supporting horizontal force equal to 100 percent of luminaire weight and vertical force equal to 400 percent of luminaire weight.

2. Sustainable Design Features:

a. Corporate Sustainability Report: Provide [**third-party-verified**]corporate sustainability report that is publicly available from manufacturer and that includes environmental impacts of extraction operations and activities associated with product and its supply chain.
b. Regional Materials (LEED): Provide documentation if product is sourced (extracted, manufactured, or purchased) within **100 miles (160 km)** of Project site.
c. Regional Materials (IgCC/ASHRAE 189.1): Provide documentation if product is sourced (extracted, harvested, recovered, or manufactured) within **500 miles (800 km)** of Project site. Identify percentage of product's travel that is by rail or water.
d. Third-Party Certification: Third-party certification, in accordance with multiple attribute standard(s) developed by consensus-based process from an approved standard development organization, is publicly available for product.
e. Third-Party-Verified Product Life-Cycle Assessment: Assessment covering cradle-to-gate scope, in accordance with ISO 14040 and ISO 14044, is publicly available for product.

3. Other Available Features Required by the Project:

a. Hook Hangers: Integrated assembly matched to luminaire, supply voltage, and equipment with threaded attachment, cord, and locking-type plug.
b. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, [**12 gage (2.68 mm)**]<**Insert size**> wire supports [**adjustable to**][**10 ft (3 m)**]<**Insert value**> in length.
c. Aircraft Cables: [**5/32 inch (4 mm)**]<**Insert value**> diameter aircraft cable supports [**adjustable to**][**10 ft (3 m)**]<**Insert value**> in length.
d. Single-Stem Hangers: **1/2 inch (13 mm)** nominal diameter steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
e. Rod Hangers: **3/16 inch (5 mm)** nominal diameter, cadmium-plated, threaded steel rod.

2.4 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing lighting equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Diffusers and Lenses: [**One for every 100**]<**Insert quantity**> of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: [**One for every 20**]<**Insert quantity**> of each type and rating installed. Furnish at least one of each type.

B. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Incandescent Lamps: [**10 for every 100**]<**Insert quantity**> of each type and rating installed. Furnish at least one of each type.
2. Luminaire-Mounted Emergency Battery Packs: [**One for every 20**][**One for every 50**]<**Insert quantity**> of each type and rating installed. Furnish at least one of each type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Lighting: If approved by Architect, specified luminaires for the Project may be installed for temporary lighting. Install and energize minimum quantity of luminaires necessary to meet needs of construction activities. When construction is sufficiently complete, remove, disassemble, clean, and relamp luminaires used for temporary lighting before reinstalling for the Project's delivery.

3.3 SELECTION OF LUMINAIRES

A. Finished Spaces:

1. Location: <**Insert list of product types**>.

B. Unfinished Spaces:

1. Location: <**Insert list of product types**>.

3.4 INSTALLATION OF LIGHTING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
3. Work in Confined Spaces: NFPA 350.
4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
5. Installation of Indoor Lighting Systems: NECA NEIS 500.
6. Installation of Exterior Lighting Systems: NECA NEIS 501.
7. Installation of Industrial Lighting Systems: NECA NEIS 502.
8. Installation of Luminaires, Lampholders, and Lamps: Article 410 of NFPA 70.
9. Installation of Extra-Low-Voltage Lighting: Article 411 of NFPA 70.
10. Installation of Lighting for Sensitive Electronic Equipment: Article 647 of NFPA 70.
11. Installation of Emergency Lighting and Exit Signs: ICC IBC, NFPA 101, and Parts IV and V in Article 700 of NFPA 70.
12. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install luminaires level, plumb, and square with finished floor or grade unless otherwise indicated.
2. Install luminaires at height and aiming angle as indicated on the Drawings.
3. Coordinate layout and installation of luminaires with other construction.
4. Adjust luminaires that require field adjustment or aiming.[**Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.**]

5. Exterior Bollard Luminaires:

   a. Align units for optimum directional alignment of light distribution.
   b. Install on concrete base with top [**4 inch (100 mm)**]<**Insert dimension**> above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

6. Exterior In-Ground Luminaires:

   a. Install on concrete base with top [**4 inch (100 mm)**]<**Insert dimension**> above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

7. Exterior Corrosion Prevention:

   a. Do not use aluminum in contact with earth or concrete. When in direct contact with dissimilar metals, protect aluminum with insulating fittings or treatment.
   b. When embedding steel conduits in concrete, wrap conduit with **10 mil (0.254 mm)** thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

8. Flush-Mounted Luminaire Support:

   a. Secured to outlet box.
   b. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   c. Trim ring flush with finished surface.

9. Wall-Mounted Luminaire Support: [**Attached to structural members in walls**][**Attached to a minimum 1/8 inch (3 mm) backing plate attached to wall structural members**][**Attached using through bolts and backing plates on either side of wall**]<**Insert means of attachment**>.

   a. Do not attach luminaires directly to gypsum board.

10. Suspended Luminaire Support:

    a. Ceiling Mount:

       1) Hook hangers.
       2) [**Two**]<**Insert number**> wires.
       3) [**Two**][**Four**]<**Insert number**> aircraft cables.

    b. Pendants and Rods: Where longer than **48 inch (1220 mm)**, brace to limit swinging.
    c. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
    d. Continuous Rows of Luminaires: Provide tubing or stem for wiring at one point and [**tubing or rod**][**wire support**] for suspension for each unit length of luminaire chassis, including one at each end.
    e. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

11. Ceiling-Grid-Mounted Luminaire Support:

a. Install ceiling support system rods or wires[**, independent of the ceiling suspension devices,**] for each luminaire. Locate not more than **6 inch (150 mm)** from luminaire corners.
b. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for application.
c. Luminaires of Sizes Smaller than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with no fewer than two **3/4 inch (20 mm)** metal channels spanning and secured to ceiling tees.
d. Seismic Restraint: Install at least one independent support rod or wire from structure to tab on luminaire. Wire or rod must have breaking strength for luminaire weight with safety factor of 3.0.

12. Remote Mounting of Ballasts or Drivers: Do not exceed distance between ballast or driver and luminaire recommended by ballast or driver manufacturer.
13. Emergency Power Units: Secure with approved fasteners in four or more locations, spaced near corners of unit.
14. Install wiring connections for luminaires.
15. Identification: Provide labels for luminaires and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Provide warning signs.
c. Label each enclosure with engraved metal or laminated-plastic nameplate.

16. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

E. Systems Integration: Integrate lighting control devices and equipment with electrical power connections for operation of luminaires as specified.

3.5 FIELD QUALITY CONTROL OF LIGHTING

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Field Tests and Inspections of Lighting Installations:

1. [**Owner**][**Tenant**] will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
3. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
4. Verify operation of photoelectric controls.
5. Exterior Illumination Tests:

a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.

F. Nonconforming Work:

1. Luminaire will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project's site.

3.6 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Burn-in lamps that require specific aging period to operate properly, prior to occupancy by Owner.
3. Charge [**emergency power units**][**and**][**batteries**] minimum of one hour and depress switch to conduct short-duration test.
4. Charge [**emergency power units**][**and**][**batteries**] minimum of 24 hours and conduct one-hour

discharge test.

5. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project's site.

3.7 ADJUSTING

A. Luminaire Aiming Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting aiming direction of luminaires to suit occupied conditions. Make up to [**two**]<**Insert number**> visits to the Project's site during other-than-normal hours for this purpose. Some of the Work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
3. Adjust aim of luminaires in presence of Architect.

3.8 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain luminaires[**and photoelectric controls**].

2. [**Provide video recordings of training sessions to Owner.**][**Allow Owner to record training sessions.**]

3.9 PROTECTION

A. After installation, protect lighting equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 50 00 00

Task	Specification	Specification Description
26 51 00 00	26 50 00 00	Lighting
26 51 13 00	26 50 00 00	Lighting
26 51 16 00	26 50 00 00	Lighting
26 51 19 00	26 01 00 00	Supplemental Requirements for Electrical
26 51 19 00	26 50 00 00	Lighting
26 51 23 00	26 50 00 00	Lighting
26 51 33 00	02 84 16 00	Handling of Lighting Ballasts and Lamps Containing PCBs and Mercury
26 51 33 00	26 50 00 00	Lighting
26 52 00 00	26 50 00 00	Lighting
26 52 13 00	26 50 00 00	Lighting
26 52 13 13	26 50 00 00	Lighting
26 52 13 16	26 50 00 00	Lighting
26 54 00 00	26 50 00 00	Lighting
26 54 19 00	26 50 00 00	Lighting
26 55 00 00	26 50 00 00	Lighting
26 55 13 00	26 50 00 00	Lighting
26 55 16 00	26 50 00 00	Lighting
26 55 29 00	26 50 00 00	Lighting
26 55 53 00	26 50 00 00	Lighting
26 55 53 11	26 50 00 00	Lighting
26 55 53 12	26 50 00 00	Lighting
26 55 53 13	26 50 00 00	Lighting

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SECTION 26 55 61 00 - THEATRICAL LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Luminaires and accessories.
2. Distribution components.
3. Lighting control system.
4. Desktop operator workstation.
5. Rigging components.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 284600 "Fire Detection and Alarm" specifies fire-alarm control panels and cabling referenced by this Section.

1.2 DEFINITIONS

A. Channel: An individual control output on a control console, accessed and regulated by a slider, switch, or button; or in some cases, accessed by a discretely assigned address and regulated by a data input apparatus.

B. Control Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.

C. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.

D. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For theatrical lighting.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Detail fabrication and installation for dimmer racks and arrangements, characteristics, and circuit assignments of various modules and rack-mounted accessories.
3. Elevation views of front, rear, and side panels indicating devices and controls, including

illustrations and dimensioned outline drawings.
4. Include diagrams for power, signal, and control wiring. Show connections, circuits, and channel assignments.
5. Equipment legend showing a unified system of designations for lighting instruments, panels, dimmers, circuits, and equipment.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plan(s), and other details drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances for operation, maintenance, and environmental conditions.
2. Areas above and around dimming equipment where piping and ducts are prohibited.
3. Rack layout and relationships between components and adjacent structural and mechanical elements.

B. Qualification Data: For Installer.

C. Seismic Qualification Data: Certificates, for lighting equipment, distribution equipment, and rigging components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires, distribution components, software operating manuals, and controls to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructional DVD: Professionally produced informational presentation to provide comprehensive instructions for equipment installation, connectivity, programing, and functional use. Information provided shall be specific to equipment provided for Project and shall include ancillary equipment and its integration into the theatrical lighting control system.
b. Control-Console Introduction:

1) Descriptions of controls and features.
2) Software instruction manuals.
3) Setup requirements for unit and related equipment.
4) Default settings.
5) Maintenance procedures and schedules.

c. Control-Console Operation:

1) Elementary on-off operation.
2) How to set cues manually.
3) How to patch dimmer to channels electronically.
4) How to operate presets manually.
5) How to operate fundamental memory.
6) How to set and record simple cues.
7) How to recall, play back, and revise cues and scenes.
8) How to use submasters, groups, focus points, fader channels; and how to split cues, store and recall programs, set up special effects, and print out cues.
9) How to set up and run system for a typical event or performance.
10) How to get help.

d. Dimming Racks:

1) Descriptions of features, functions, and safety and security precautions.
2) Descriptions of dimming module features, software-driven functions, non-dim functions, and associated racking systems.
3) How to compare connected loads against dimmer capacity ratings.
4) How to terminate basic power-in and power-out connections.
5) Basic maintenance requirements, including need for qualified electrician for internal maintenance; basic maintenance schedule; techniques for keeping terminals properly tightened, filter screens clean, and overheat sensors checked; and techniques for performing other required servicing.
6) How to adjust dimmer-control module.
7) How to get help.
8) Description of warranty.

e. System Troubleshooting: Procedures for handling problems with common software, programming, control console, dimmer rack, and distribution system; include information on how to get help.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB drive or compact disk, complete with data files.
3. Device address list if applicable.
4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Dimmer Modules: [**One**]<**Insert number**> of each type and rating installed.
2. Fuses: Three of each kind.
3. Lamps: [**One**]<**Insert number**> for every [**10**]<**Insert number**> of each type and rating installed. Furnish at least one of each type.
4. Glass Roundels: [**One**]<**Insert number**> for every [**three**]<**Insert number**> of each type and color installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of the complete dimming control system and luminaires that fail in materials or workmanship within specified warranty period.

1. Lamps are not included as part of the special warranty.
2. Warranty Period: Cost to repair or replace parts for [**two**]<**Insert number**> years from date of Substantial Completion.
3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for [**eight**]<**Insert number**> years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Dimmer racks shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

2.2 PLUG CONNECTORS

A. Pin Type: ANSI E1.24, two pole, three wire, 20 A.

B. Twist-Locking Type: NEMA WD 6, two pole, three wire, 20 A.

2.3 LUMINAIRES AND ACCESSORIES

A. General:

1. Comply with UL 1573 and listed and labeled by an NRTL.
2. Luminaires: Equipped with pigtail, yoke with pipe clamp, safety cable for batten mounting, and filter holder.
3. Metal Parts: Free of burrs, sharp corners, and edges.
4. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
5. Luminaire Doors and Their Internal Access: Smooth operating, free of light leakage under operating conditions, and arranged to permit relamping without use of tools. Doors, lenses, diffusers, and other pieces arranged to prevent accidental falling during relamping and when secured in operating position.
6. Pigtail: Factory wired, **36-inch- (900-mm-)** long, three-wire cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.
7. Lamp Sockets: Relampable without disturbing alignment or focus adjustment.

8. Luminaire Ventilation Openings: Baffled against light leaks.
9. Luminaire Operating Controls and Handles: Thermally insulated.
10. Lenses: Borosilicate glass in silicone mountings.
11. Framing Shutters: Stainless steel, four way; with each blade in a separate plane under adjustable tension mounting. Blades adjust plus or minus 30 degrees of rotation in gate for 120-degree-minimum total angular rotation between adjacent blades.
12. Color Filter Frame Holder: Attached to front of luminaire.
13. Luminaire Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

B. Ellipsoidal Spotlights: Luminaires with an elliptical reflector mounted in a fixed relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a gobo, or an iris. The shaped beam shall then be focused by a system of lenses.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Electronic Theatre Controls, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Lighting & Electronics, Inc.**]
   e. [**Philips; Signify North America; Signify Holding**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**Electronic Theatre Controls, Inc**]
   c. [**Leviton Manufacturing Co., Inc.**]
   d. [**Lighting & Electronics, Inc.**]
   e. [**Philips; Signify North America; Signify Holding**]
   f. <**Insert manufacturer's name**>

3. Tag ES-1 :

   a. Lamp: [**1000 W Q1000/4CL, ANSI FEL**][**750 W ANSI HPL**]<**Insert description**>.
   b. Pattern Holders: Three for each luminaire, with framing shutters.
   c. Color Frame: Black, metal.
   d. Minimum Cosine Illumination Performance Ratings When Operated with ANSI 1.9, FEL Lamp:

      1) 171,000-beam candlepower at 20-degree field angle.
      2) 48,000-beam candlepower at 40-degree field angle.

   e. Minimum Cosine Illumination Performance Ratings When Operated with ANSI 1.9 Series, HPL Lamp:

      1) 124,300-beam candlepower at 20-degree field angle.
      2) 51,500-beam candlepower at 40-degree field angle.

C. Zoom Ellipsoidal Spotlights: Luminaires with an elliptical reflector mounted in an adjustable relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a

gobo, or an iris. The shaped beam shall then be focused by a system of lenses.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Altman Lighting Co. Inc.**]
    b. [**Electronic Theatre Controls, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Lighting & Electronics, Inc.**]
    e. [**Philips; Signify North America; Signify Holding**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Altman Lighting Co. Inc.**]
    b. [**Electronic Theatre Controls, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Lighting & Electronics, Inc.**]
    e. [**Philips; Signify North America; Signify Holding**]
    f. <**Insert manufacturer's name**>

3. Tag ZES-1 :

    a. Lamp: [**1000 W Q1000/4CL, ANSI FEL**][**750 W ANSI HPL**]<**Insert description**>.
    b. Pattern Holders: Three for each luminaire, with framing shutters.
    c. Operator adjustable from [**15- to 35**][**25- to 50**]-degree field angle.
    d. Field-angle adjustment scale label on instrument housing for field reference.
    e. Minimum Cosine Illumination Performance Rating When Operated with ANSI 1.9, FEL Lamp: 82,000-beam candlepower at 35-degree field angle.
    f. Minimum Cosine Illumination Performance Rating When Operated with ANSI 1.9, HPL Lamp: 95,330-beam candlepower at 35-degree field angle.

D. Fresnel Lens Spotlights:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Altman Lighting Co. Inc.**]
    b. [**Electronic Theatre Controls, Inc**]
    c. [**Lighting & Electronics, Inc.**]
    d. [**Philips; Signify North America; Signify Holding**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Altman Lighting Co. Inc.**]
    b. [**Electronic Theatre Controls, Inc**]

c. [**Lighting & Electronics, Inc.**]
d. [**Philips; Signify North America; Signify Holding**]
e. <**Insert manufacturer's name**>

3. Die-cast extruded-aluminum housing, with hinged front for relamping.
4. Tag FLS-1 :

a. Lamp: [**1000 W Q1000T7/4CL, ANSI EGT**][**750 W ANSI HPL**]<**Insert description**>.
b. Lens: **6 inches (152 mm)**.
c. Illumination Performance Rating When Operated with ANSI 1.9, EGT Lamp:

1) 175,000-beam candlepower at 12.5-degree field angle in spot focus.
2) 12,000-beam candlepower at 74.6-degree field angle in flood focus.

d. Illumination Performance Rating When Operated with ANSI 1.9, HPL Lamp:

1) 124,300-beam candlepower at 20-degree field angle in spot focus.
2) 17,600-beam candlepower at 65-degree field angle in flood focus.

e. Barn Doors: Two four-leaf rotatable metal flaps for every three luminaires.

E. Follow Spotlights:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Altman Lighting Co. Inc.**]
b. [**Lycian Stage Lighting**]
c. [**Strong International**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Altman Lighting Co. Inc.**]
b. [**Lycian Stage Lighting**]
c. [**Strong International**]
d. <**Insert manufacturer's name**>

3. Tag FS-1 :

a. Lamp:

1) [**Metal halide; G22 medium bi-post; CRI: 90; color: 6000 K; life: 750 hours; HMI 575 W/GS 95 V**]<**Insert description**>.
2) Quartz-projector type, <**Insert number**> W, for <**Insert number**>-V supply.

b. Adjustable lenses in metal housing.
c. Adjustable, underslung base stand mounted on **3-inch (75-mm)**, locking-type, rubber-tired, ball-bearing casters.
d. Adjustable lamp holder and socket assembly with precision tuning adjustment; allows user to replace lamp without tools.
e. Three-leaf, full-range mechanical dimmer.

f. Adjustable iris and framing shutters.
g. Automatic color boom.
h. Removable power cable, **25 feet (8 m)** long.
i. Iris-Open, Spot-Focus Performance: [**800,000**]<**Insert value**> -beam candlepower at [**7.2**]<**Insert number**>-degree field angle.
j. Iris-Open, Flood-Focus Performance: [**330,000**]<**Insert value**> -beam candlepower at [**12.2**]<**Insert number**>-degree field angle.

F. PAR Lamp Holders:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Altman Lighting Co. Inc.**]
   b. [**James Thomas Engineering, Inc.**]
   c. [**Lighting & Electronics, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Altman Lighting Co. Inc.**]
   b. [**James Thomas Engineering, Inc.**]
   c. [**Lighting & Electronics, Inc.**]
   d. <**Insert manufacturer's name**>

3. Tag PLH-1 :

   a. Lamp: [**300 W PAR 38**]<**Insert description**>.
   b. Housing: Steel or aluminum,[**flat black color,**] with porcelain-plated shell socket.
   c. Barn Doors: Two four-leaf rotatable metal flaps for every three luminaires.

4. Tag PLH-2 :

   a. Lamp: [**575 W tungsten halogen; 90 GLA 575 W; 120 V; color: 3050 K, ANSI GKV**]<**Insert description**>.
   b. Housing: Steel or aluminum, with porcelain-plated shell socket[**and color frame**].
   c. Barn Doors: Two four-leaf rotatable metal flaps for every three luminaires.
   d. With Lens Holder and Replaceable Lenses:

      1) - Very narrow spot.
      2) - Narrow spot.
      3) - Medium flood.
      4) - Wide flood.
      5) - Very wide flood.

   e. [**Motorized**][**Manual**] color wheel.

G. Borderlight Units: Compartmented, three-circuit striplight with nine [**120-W, PAR 38/SP**][**120-W, PAR 38/FL**][**250-W, PAR 38/SP**] lamps in porcelain sockets and steel sheet housing, **90 inches (2286 mm)** long. Compartments shall be in line and wired on [**two**][**three**][**four**] alternate circuits, each producing a different color.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Altman Lighting Co. Inc.**]
    b. [**Lighting & Electronics, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Altman Lighting Co. Inc.**]
    b. [**Lighting & Electronics, Inc.**]
    c. <**Insert manufacturer's name**>

3. Front Door: Spring loaded; designed to hold either filter frames or color roundels.
4. Color Roundels: One for each lamp; [**alternating red, blue, and clear**]<**Insert colors**>.

    a. Additional Roundels: <**Insert number**> amber and <**Insert number**> green.

5. Hanger: Adjustable, steel-strap type equipped at each end with pipe clamp and safety cable for suspension from a batten.
6. Housing shall be constructed of **0.036-inch (0.9-mm)** steel with louvers for heat dissipation and baffles for control of light leaks within luminaire.

H. Cyclorama Lights: Suitable for lighting cycloramas from above.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Altman Lighting Co. Inc.**]
    b. [**James Thomas Engineering, Inc.**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Lighting & Electronics, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Altman Lighting Co. Inc.**]
    b. [**James Thomas Engineering, Inc.**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. [**Lighting & Electronics, Inc.**]
    e. <**Insert manufacturer's name**>

3. Tag CL-1 :

    a. Lamp: [**1000 W Q1000T3/1CL, ANSI FFT**]<**Insert description**>.
    b. Housing: Aluminum[**or steel**][**, flat black color**][**, with color frame**].

I. Black Lights: Portable, producing a wash of UV light for special effects.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Altman Lighting Co. Inc.**]
    b. [**Lighting & Electronics, Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Altman Lighting Co. Inc.**]
    b. [**Lighting & Electronics, Inc.**]
    c. <**Insert manufacturer's name**>

3. Tag BL-1 :

    a. Lamp: [**250-W blacklight flood, H37KB-250, with integral filter to eliminate far-UV effect while maximizing the near-UV effect**]<**Insert description**>.
    b. Housing: Steel[**or aluminum**][**, flat black color**], with carry handle.
    c. C-clamp for using on light pipe.

J. Moving Lights:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**High End Systems, Inc**]
    b. [**Martin Professional, Inc**]
    c. [**Vari-Lite; Signify North America; Signify Holding**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**High End Systems, Inc**]
    b. [**Martin Professional, Inc**]
    c. [**Vari-Lite; Signify North America; Signify Holding**]
    d. <**Insert manufacturer's name**>

3. Tag ML-1 :

    a. General: 700-W, 120-V, metal halide, motorized remote-controlled lighting instrument; NRTL listed.
    b. Lamp: Short-arc metal halide, 14,500 lumens; color temperature of 5600 K, CRI of 80.
    c. Color System: Three-filter CYM (cyan, yellow, magenta) cross-fading mechanism, and 11 standard colors on a fixed wheel.
    d. Optics: Zoom optics with continuously variable field angle from 18.5 to 42 degrees, programmable over a timed range of 2 seconds to 20 minutes; with a mechanical iris for beam-size control. Variable beam focus to soften the edges of gobos and light beams.

Zoom combined with iris can project a beam with a field angle of 8 degrees.

e. Dimming: Coated glass dimmer wheel, with controls to provide smooth timed fades.
f. Strobe for strobe lighting effects.
g. Gobo: One rotating wheel with five rotatable wheel positions and one open position. One fixed gobo wheel with 11 pattern positions and one open position.
h. Beam Orientation Control: Smooth pan and tilt using a three-phase stepper motor system. Pan, 540 degrees; tilt, 270 degrees at 0.3-degree repeatability on either axis.
i. Control: ANSI E1.11 (USITT DMX512-A) protocol using five pin connectors.

2.4 DISTRIBUTION COMPONENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Electronic Theatre Controls, Inc**]
2. [**ESL Power Systems, Inc.**]
3. [**Performance Electric**]
4. [**SSRC**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Electronic Theatre Controls, Inc**]
2. [**ESL Power Systems, Inc.**]
3. [**Performance Electric**]
4. [**SSRC**]
5. <**Insert manufacturer's name**>

C. Connector Strip: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly.

1. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of **3 by 4-1/2 inches (75 by 115 mm)**.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
3. Receptacles:

a. Pigtail mounted, **18 inches (450 mm)** long, with strain relief at wireway wall penetration.
b. Flush mounted in wireway cover.

4. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
5. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
6. Mounting Hardware: Furnished with each unit; permits surface, single-pipe-bracket, or double-pipe-bracket mounting.
7. Finish: Semigloss or matte black.

D. Plug-in Boxes: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly, **24 inches (600 mm)** long unless otherwise indicated; with the following features:

1. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of **3 by 4-1/2 inches (75 by 115 mm)**.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
3. Receptacles:

a. Pigtail mounted, **18 inches (450 mm)** long, with strain relief at wireway wall penetration.
b. Flush mounted in wireway cover.

4. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
5. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
6. Surface or Grid Mounting: With accessories for surface mounting or with pipe-mounting accessory bracket.
7. Recessed Mounting: With flanged cover suitable for recessed mounting in wall.
8. Finish: Semigloss or matte black.

E. Gridiron Junction Boxes: Listed and labeled by an NRTL; factory wired with terminal strips and concentric knockouts on all sides.

1. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable; and brackets for surface or pipe mounting.
3. Finish: Semigloss or matte black.

F. Floor Pockets: Listed and labeled by an NRTL; flush-mounted, receptacle outlet assembly.

1. Box: **0.0598-inch (1.5-mm)** steel sheet, **10 inches (250 mm)** deep.
2. Cover Plate: Steel, cast iron, or cast aluminum with nonskid safety tread surface and self-closing, hinged door with cable notches.
3. Barrier for allowing installation of control-voltage control receptacle for console input or handheld remotes.

G. Company Switch: Listed and labeled by an NRTL as complying with UL 891.

1. Enclosure: NEMA 250 [**Type 3R**][**Type 4X**] with interlocked, full-height doors.
2. Breakers:

a. General Requirements: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.
b. Features and Accessories:

1) Main molded case circuit breaker with safety interlock to doors.
2) Standard frame sizes, trip ratings, and number of poles.
3) Lugs: [**Mechanical**][**Compression**] type, suitable for number, size, trip ratings, and conductor material.
4) Application Listing: Appropriate for application; Type HID for feeding lighting circuits.
5) Ground-Fault Protection: Comply with UL 1053; [**integrally mounted, self-powered**][**remote-mounted and powered**] type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

3. Receptacles:

a. [**Locking**][**Locking, cam style**] color coded, wired to main circuit breaker.
b. Cable entry at [**side**][**bottom**] of enclosure.
c. Rated for [**200**][**400**] amps at 600-V ac.
d. Integral safety interlock allowing access only if main circuit breaker is in "OFF" position.

4. Integral ground lug for facility ground conductor.

2.5 WIRE AND CABLE

A. Building Wire in Raceways: Comply with requirements specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Portable Power Cable: Listed and labeled by an NRTL; flexible stage and lighting power cable; Type SC, SCE, or SCT; 600 V; multiconductor; 60 deg C temperature rating.

C. Ethernet Cabling: Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables."

1. For 10/100BaseT, comply with provisions for UTP cable and hardware.
2. For 10Base-FL, comply with provisions for [**50/125**][**62.5/125**]-micrometer, multimode, optical-fiber cable and hardware.

D. ANSI E1.11 (USITT DMX512-A) Control Cabling: Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables."

1. Standard Cable, NFPA 70 [**Type CM**][**or**][**Type CMG**]:

a. Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, [**No. 22 AWG**][**No. 24 AWG**], stranded, tinned-copper conductors.
b. Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
c. Outer Shield: 90 percent coverage, tinned-copper braid.
d. Outer Shield Drain Wire: Stranded, tinned copper.
e. Listed and labeled in accordance with UL 444.

2. Plenum-Rated Cable, NFPA 70 Type CMP:

a. Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, [**No. 22 AWG**][**No. 24 AWG**], stranded, tinned-copper conductors.
b. Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
c. Outer Shield: 90 percent coverage, tinned-copper braid.
d. Outer Shield Drain Wire: Stranded, tinned copper.
e. Listed and labeled in accordance with UL 444.
f. Investigate insulation and jacket materials in accordance with UL 2257.

E. Control-Voltage Control Cabling:

1. Control-Cable Conductors:

a. Class 1 Control Circuits:

1) Conductor: Stranded copper, [**Type THHN-THWN, single-conductor wire complying with UL 83**][**Type XHHW, single-conductor wire complying with UL 44**][**Type XHHW, multi-conductor cable complying with UL 44**].
2) Method: [**In raceway**][**Concealed in building finishes**][**In cable tray**].

b. Class 2 Control Circuits:

1) Conductor: Stranded copper, [**Type THHN-THWN, single-conductor wire complying with UL 83**][**Type XHHW, single-conductor wire complying with UL 44**][**Type XHHW, multi-conductor cable complying with UL 44**].
2) Method: [**In raceway**][**Concealed in building finishes**][**In cable tray**].

c. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW complying with UL

83.

2. Standard Cable, NFPA 70 Type CMG:

   a. One pair, twisted, [**No. 16 AWG, stranded**][**or**][**No. 18 AWG, stranded (19x30)**], tinned-copper conductors.
   b. Unshielded.
   c. Listed and labeled in accordance with UL 444.

3. Plenum-Rated Cable, NFPA 70 Type CMP:

   a. One pair, twisted, [**No. 16 AWG, stranded (19x29)**][**or**][**No. 18 AWG, stranded (19x30)**], tinned-copper conductors.
   b. Unshielded.
   c. Listed and labeled in accordance with UL 444.
   d. Investigate insulation and jacket materials in accordance with UL 2257.

2.6 LIGHTING CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   1. [**Electronic Theatre Controls, Inc**]
   2. [**Entertainment Technology**]
   3. [**Leviton Manufacturing Co., Inc.**]
   4. [**Philips; Signify North America; Signify Holding**]
   5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   1. [**Electronic Theatre Controls, Inc**]
   2. [**Entertainment Technology**]
   3. [**Leviton Manufacturing Co., Inc.**]
   4. [**Philips; Signify North America; Signify Holding**]
   5. <**Insert manufacturer's name**>

C. Description: Microprocessor-based modular system consisting of dimmer and control modules operated from remote-control stations and a control console.

   1. Comply with UL 508.
   2. Comply with ANSI E1.11 (USITT DMX512-A) [**RDM**][**and**][**or**][**ACN**] for data transmission.

D. Dimmer Racks: Listed and labeled by an NRTL; dead-front, front-access, [**wall-mounted**][**freestanding**] rack for mounting modular dimmers; formed-steel or extruded-aluminum structural members; completely enclosed with steel or aluminum panels. Painted with manufacturer's standard corrosion-resistant primer and finish coats, and having the following features:

   1. Primary Circuit Breaker: Fault-current withstand rating of the rack; not less than [**10,000 A**][**50,000 A**]<**Insert number**>, symmetrical.
   2. Hinged, locking front door, with openings to allow air intake across the face of all dimmer modules.
   3. Individual rack sections shall not exceed **84 inches high by 25 inches deep by 30 inches wide**

(2134 mm high by 635 mm deep by 762 mm wide). Multisection racks shall be interconnected with busbars.

4. For each module position, provide support rails and control-pin configurations, constructed for precise alignment of dimmer modules into power and signal connector sockets, with keyed connections for power capacity restrictions.
5. Forced-air cooling of each rack for maintaining operating temperature at each dimmer, assuming full load, in ambient temperature not to exceed 40 deg C. Exhaust rates shall be variable, using temperature sensors and fan-speed control electronics. Individual control of multiple fans is acceptable in lieu of fan-speed control. Fan(s) shall start and stop automatically. Fan noise at full load shall be less than 3.1 sones.
6. Each rack shall have an automatic air-temperature sensor to shut off all dimmers in the rack, should the internal temperature rise above maximum safe operating limits. In an overheat condition, the fan shall continue operating. When a safe operating temperature is restored, the system shall automatically reset to allow normal user control.
7. Fabricate and test dimmer racks to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Dimmers: Modular solid-state units that operate smoothly over their operating ranges without audible lamp noise or radio-frequency interference at any setting. Modules shall be dead-front, draw-out type with floating line, load, and control sockets for smooth insertion and withdrawal; with load-side thermal-magnetic circuit breaker, speed-controlled cooling fan, and overtemperature sensor.

1. Non-Dim Units: On-off relay control only. Capable of serving inductive loads, such as motors or HID luminaires.
2. Surge Protection: Modules shall withstand power-line surges of 6000 V/3000 A according to IEEE C62.41.1 and IEEE C62.41.2.
3. Filter each dimmed circuit to provide a minimum 350-mic.sec., current-rise time at a 90-degree conduction angle at 50 percent of rated dimmer capacity. At any load within rating, rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load current waveform.

F. Control System: Microprocessor-based control system, ANSI E1.11 (USITT DMX512-A) [**RDM**][**and**][**or**][**ACN**] protocol, with a nonvolatile system memory to adjust dimmer channel settings for different scenes, to patch dimmers to channels, and to manually or automatically change dimmer settings from one preset scene to another.

1. Control shall support Ethernet-based LAN at devices.
2. Provide means to create and monitor show data on a PC using software by console manufacturer. Software shall be capable of the following:

    a. Creating show and providing for use of show files.
    b. Playing back show in a console-simulation mode.
    c. Accessing all remote-control stations associated with the console and control system.
    d. Providing standard Ethernet connection between the console control system and the lighting system components.

3. Display the following system status information on a color, [17-inch (430-mm) **LCD**]<**Insert size and type**> monitor associated with the control console:

    a. Current channel intensities.
    b. Cue information.
    c. Monitor.

4. Moving Lights: Include a standard control library, a program patch specific to luminaire(s) provided, and selective programming with ANSI E1.11 (USITT DMX512-A) [**RDM**][**and**][**or**][**ACN**] addressing of fade, focus points, beam, image, color, <**Insert attributes**> and position.

G. Control Console: Tabletop unit with manual and computer-based programming controls, memory units, indicating devices, and the following features:

1. Grand-master level control.
2. Blackout switch.
3. Multiple submaster level controls with overlapping pile-on performance.
4. Bump buttons for momentary control of channels or submasters, one for each submaster level control.
5. Two cross-fade controls for split dipless fade between scenes, each with its own fade progress indicator.
6. One set of scene level controls for each scene when used in two-scene preset mode. Second set of scene level controls to allow setting levels into memory for expanded single scenes when used in multiple single-channel scene mode. Each set shall have same quantity of scene level controls as is used for submaster level controls.
7. Multibutton keypad for programming in multiscene memory mode.
8. Fade time control for assigning fade time to cues, with individual cue adjustment from one second to five minutes, minimum.
9. Digital display, for operating menus and memory readout.
10. Controls for setting levels into memory.
11. Cord and connector for connecting console to outlets for console power and control.

H. System Operation: Selectable between multichannel two-scene preset and four-channel single-scene memory. Console features include electronic patching of control signals for up to 512 dimmers and off-line data storage using USB drive port. Operational capability includes the following:

1. Live and blind programming.
2. Special effects programmability for automatic operation of lights in pulsating, sequential dimming and brightening, and other special operating modes. Special effects menu displays operator guidance for programming and individual step levels.
3. Signal from fire-alarm control panel that automatically brings selected circuits to fully on or fully bright condition, overriding normal dimming and on-off controls.
4. Inserting cues between designated cues without renumbering.
5. Out-of-sequence playback of cues.
6. Controlling houselights and stage lights from console by assigning their dimmers or non-dim on-off controls to a channel.
7. Retaining programmed cues in memory for minimum of one year after power outage.
8. Automatic sequential execution of programmed cues.
9. Printing cues using parallel or serial printer port, cable, and printer. Cable and printer are not included with this system.

I. Console Power and Control Outlets: Multiple receptacles matched to connector on console connector cord.

J. House Lighting Control Station: Architectural-type, multichannel, remote-dimmer-control station with the following features:

1. System controls designated houselights, stage lights, and other lights.
2. Stage lighting controls compatible with dimming and control system.
3. Flush mounting.
4. [**Four**][**Eight**][**Sixteen**] channels, each with slider potentiometer control.
5. Master-slider potentiometer that controls lights on all channels proportionally from completely dimmed to degree of brightness that corresponds to individual slider positions.
6. Fully on switch that turns all channels on at full brightness regardless of slider position.
7. Take-control/off switch that places station in control of channels and sets lighting to levels dictated by channel and master-slider controls.

8. Legend on face of wall plate that identifies items as "House Lighting Control Station" and identifies functions of each slider and switch position, with slider positions individually graduated from zero to maximum.
9. Illuminated push buttons for activating preset scenes of house lighting and labeled [**"Entry."**][**"Panic."**][**"Entry" and "Panic."**]
10. Flush wall mounted unless otherwise indicated.

K. Entry Station: Push button activates or deactivates indicating light and presets scene of house lighting control system.

1. LED indicating light illuminates when preset command is executed.
2. Labeled "Entry."
3. Flush wall mounted unless otherwise indicated.

L. Key-Entry Station: Key-operated switch controls station to activate or deactivate indicating light and presets scene of lighting control system.

1. LED indicating light illuminates when preset command is executed.
2. Labeled "Entry."
3. Flush wall mounted unless otherwise indicated.

M. Emergency Lighting Control Station: [**Key-operated**]push button activates indicating light and brings selected dimmers to fully bright condition (i.e., the "Panic" preset). Operating push button a second time returns dimmers to previous setting.

1. Emergency mode indicating light.
2. Labeled "Emergency Lights."

N. Flush wall mounted unless otherwise indicated.

2.7 DESKTOP OPERATOR WORKSTATION

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Dell Technologies Inc.**]
2. [**HP Inc.**]
3. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
4. <**Insert manufacturer's name**>

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Capable of running [**Microsoft Windows**]<**Insert operating system name**>.
3. ENERGY STAR compliant.

D. Personal Computer:

1. Minimum Processor Speed: <**Insert gigahertz**>.
2. RAM:

    a. Capacity: [**2**][**4**][**8**]<**Insert value**>[**GB**].
    b. Speed and Type: [**1333**]<**Insert value**> MHz, <**Insert type**>.

3. Hard Drive:

    a. Number of Hard Drives: [**One**][**Two**]<**Insert number**>.
    b. Capacity: <**Insert number and measurement unit**>.
    c. Minimum Average Seek Time: <**Insert number and measurement unit**>.
    d. Cache Buffer Size: <**Insert number and measurement unit**>.
    e. <**Insert requirements**>.

4. Second Hard Drive:

    a. Capacity: <**Insert number and measurement unit**>.
    b. Minimum Average Seek Time: <**Insert number and measurement unit**>.
    c. Cache Buffer Size: <**Insert number and measurement unit**>.
    d. <**Insert requirements**>.

5. Optical Drive:

    a. Type: <**Insert type**>.
    b. Minimum Average Access Time: <**Insert number**> ms.
    c. Data Transfer Speed: <**Insert number**>[**MB**][**TB**]/s.
    d. Reading Formats: Data, audio, recordable, <**Insert other**> and rewritable.

6. Optical Read and Write Drive:

    a. Include with at least 2 MB of data buffer.
    b. Type: <**Insert type**>.
    c. Minimum Data Buffer Capacity: <**Insert number and measurement unit**>.
    d. Minimum Average Access Time: <**Insert number**> ms.
    e. Nominal Data Transfer Rates:

        1) Reading: <**Insert number**>[**MB**][**TB**]/s.
        2) Writing: <**Insert number**>[**MB**][**TB**]/s.

    f. Average access time of 150 ms or less.
    g. MTBF of at least 100,000 power-on hours.

7. Expansion Slots: Minimum of 4, [**32**][**64**]<**Insert number**> bit.
8. Video Card:

    a. Capable of supporting [**one**][**two**][**three**][**four**] monitor(s.)
    b. Resolution: [**1920 by 1200**]<**Insert values**> pixels minimum for each monitor.
    c. RAM: <**Insert number**>[**MB**][**GB**][**TB**].
    d. Controller Speed: <**Insert number**>[**MHz**][**GHz**].
    e. On-Board Memory Speed: <**Insert number**>[**MHz**][**GHz**].
    f. On-Board Memory Data Width: <**Insert number**> bit.

9. Sound Card:

a. At least 128 voice wavetable synthesis.
b. Capable of delivering three-dimensional sound effects.
c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

10. Network Interface Card: Include card with connection, as applicable.

a. 10-100-1000 base TX Ethernet with RJ45 connector port.
b. 100 base FX Ethernet with SC or ST port.

11. Wireless Ethernet, 802.11 a/b/g/n.
12. Optical Modem: Full duplex link for connection to fiber-optic cable provided.
13. I/O Ports:

a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
b. One serial port.
c. One parallel port.
d. Two PS/2 ports.
e. One RJ-45.
f. One stereo line-in and line-out on back panel.
g. One microphone and headphone connector on front panel.
h. One IEEE 1394 on front and back panel with PCI-e card.
i. One ESATA port on back panel.

14. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

E. Keyboard:

1. 101 enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to **72 inches (1800 mm)** in front of workstation.

F. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to **72 inches (1800 mm)** in front of workstation.

G. Flat Panel Display Monitor:

1. Number of Displays: [**One**][**Two**]<**Insert number**>.

a. Display Support: [**Individual tilt adjustable base**][**Desk mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization**][**Wall mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization**]<**Insert description**>.

2. Color display with <**Insert inches (mm)**> diagonal viewable area.
3. Aspect Ratio: [**16 to 9**]<**Insert value**>.
4. Resolution: [**1920 by 1080**]<**Insert value**> pixels at 60 Hz with pixel size of [**0.277**]<**Insert number**> mm or smaller.
5. [**Digital**][**or**][**analog**] input signal.
6. Response Time: <**Insert number**> ms.
7. Dynamic Contrast Ratio: [**50000 to 1**]<**Insert ratio**>.
8. Brightness: [**250 cd/sq. m**]<**Insert value**>.

9. ENERGY STAR compliant.
10. Antiglare display.

H. Speakers:

1. Two, with individual controls for volume, bass, and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

I. I/O Cabling: Include applicable cabling to connect I/O devices.

J. Software:

1. Factory-installed operating system.

K. Uninterruptable power supply (UPS) unit for the workstation.

1. Provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.

a. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads, but excluding the printer. UPS shall provide [**15**]<**Insert number**> minutes of battery power.

2. Performance:

a. Input Voltage: Single phase, 120-V ac, compatible with field power source.
b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89- and 152-V ac.
d. On-Battery Output Voltage: Sine wave.
e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
g. Transfer Time: 6 ms.

3. UPS shall be automatic during fault or overload conditions.
4. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
5. Include front panel with power switch and visual indication of power, battery, fault, and temperature.
6. Unit shall include an audible alarm of faults and front panel silence feature.
7. Unit with four 120-V, 15-A receptacles.
8. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure)[**and connect the points to the monitoring and control system**].
9. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
10. Include tower models installed in ventilated cabinets at the particular installation location.

2.8 RIGGING COMPONENTS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Altman Lighting Co. Inc.**]
2. [**James Thomas Engineering, Inc.**]
3. [**SSRC**]
4. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Altman Lighting Co. Inc.**]
2. [**James Thomas Engineering, Inc.**]
3. [**SSRC**]
4. <**Insert manufacturer's name**>

C. Pipe Clamps: Malleable iron, suitable for clamping luminaires or items to pipe from **3/4 to 2 inches (20 to 51 mm)** in OD. Arranged for horizontal rotation of yoke for aiming; equipped with T-bolt to lock alignment.

D. Safety Cables: Heavy-duty, flexible steel; **30-inch (762-mm)** nominal length, with spring clip at one end and steel ring at the other end.

E. Cable Grips: [**Stainless**][**Galvanized**] steel; basket-weave type for supporting stage cables.

F. <**Insert accessories**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA NEIS 1.

B. Set permanently mounted items level, plumb, and square with ceilings and walls.

C. Indicated mounting heights are to bottom of unit for suspended items and to center of unit for wall-mounted items.

D. Mount and connect luminaires, and install and connect distribution devices.

1. If arrangement is not indicated, install so each luminaire, dimmer, house lighting circuit, control channel, and outlet circuit can be operated, and complete system demonstrated, in all operating modes.
2. Install safety cables secured to stage rigging or gridiron for all pipe-mounted electrical luminaires and equipment.

E. Dimmer Rack Mounting: Install and anchor dimmer racks level on **4-inch- (100-mm-)** high concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around full perimeter of base.
2. For dimmer racks, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to dimmer racks.

F. Comply with mounting and anchoring requirements specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548 "Vibration and Seismic Controls for Electrical Systems."

3.2 WIRING

A. Power Wiring:

1. Install wiring as specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for hardwired connections. Install wiring in raceways except cable and plug connections. Install cable strain relief device on power and control cable drops.
2. Install power wiring with a separate neutral for each output circuit from main dimmer and for each house and stage lighting circuit.

B. Signaling, Remote-Control, and Power-Limited Circuits:

1. Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables" for installation of wiring. [**Install wiring in raceways except cable and plug connections**]<**Insert wiring method**>.
2. Comply with the following unless otherwise indicated:

   a. Size conductors according to lighting control device manufacturer's written instructions.
   b. Select cable insulation, shielding, drain wire, and jacket complying with lighting control device manufacturer's written instructions.
   c. Install circuits to eliminate RFI and electromagnetic interference.

3. Remote-control circuits associated with emergency lighting control shall be installed complying with Class 1 circuit standards in NFPA 70.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes and in terminal cabinets and equipment enclosures.

E. Remove wall plates and protect devices and assemblies during painting.

F. Support luminaires, distribution components, and accessories as specified in Section 260529 "Hangers and Supports for Electrical Systems." Equip all pipe-mounted equipment with safety cables that are secured to supporting pipe.

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

B. Label each luminaire, lighting outlet, distribution device, and dimmer module with unique designation. Labels on elevated components shall be readable from the floor.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.
2. Visual and Mechanical Tests and Inspections:

a. Inspect each luminaire, outlet, module, control, and device for defects, finish failure, corrosion, physical damage, labeling by an NRTL, and nameplate.
b. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's written instructions.
c. Check tightness of electrical connections with torque wrench.
d. Verify proper protective device settings, fuse types, and ratings.
e. Record results of tests and inspections.

3. Electrical Tests: Perform tests according to manufacturer's written instructions.

a. Continuity tests of circuits.
b. Operational Tests: Connect each outlet to a luminaire and a dimmer output circuit, so each dimmer module, dimmer-control and output circuit, outlet, and luminaire in a typical operating mode will be sequentially tested. Set and operate controls to demonstrate luminaires, outlets, dimmers, and controls in a sequence that cues and reproduces actual operating functions for a typical system of the size and scope installed. Include operation and control of houselights and stage lights from each control location and station, including optional plug-in, control-console outlet locations. Record luminaire and outlet assignments, control settings, operations, cues, and observations of performance.

C. Stage lighting will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

1. Prepare a schedule of lighting outlets by number; indicate circuits, dimmers, connected luminaires, and control-channel assignments. Prepare a schedule of control settings and circuit assignments for house control channels. Prepare written reports of tests and observations. Report defective materials, workmanship, and unsatisfactory test results. Include records of repairs and adjustments made.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

B. Modify the software programming as required to comply with the Contract Documents.

3.6 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [**two**]<**Insert number**> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**]<**Insert number**> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's staff to adjust, operate, and maintain stage lighting equipment.

1. Training shall be [**one**][**two**] four-hour [**session**][**sessions**].
2. Include costs associated with the training with the equipment installation.
3. Provide a 14-day notice to Owner prior to scheduling training period.

END OF SECTION 26 55 61 00

Task	Specification	Specification Description
26 55 61 00	26 50 00 00	Lighting

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SECTION 26 55 68 00 - ATHLETIC FIELD LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Athletic field luminaires and lamps.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 055000 "Metal Fabrications" specifies pipe bollards installed by this Section.
6. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies cables installed by this Section.
7. Section 260533.13 "Conduits for Electrical Systems" specifies raceways installed by this Section.
8. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies boxes and covers installed by this Section.
9. Section 260553 "Identification for Electrical Systems" specifies identification products installed by this Section.
10. [**Section 260923 "Lighting Control Devices"**][**Section 260943.16 "Addressable Luminaire Lighting Controls"**][**Section 260943.23 "Relay-Based Lighting Controls"**][**and**][**Section 265561 "Theatrical Lighting"**] specifies lighting control equipment and cabling connections to luminaires installed by this Section.
11. Section 262716 "Electrical Cabinets and Enclosures" specifies enclosures installed by this Section.
12. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies surge protective devices installed by this Section.
13. Section 260546 "Poles for Electrical Systems" specifies poles installed by this Section.

1.2 DEFINITIONS

A. ACN: Architecture for Control Networks.

B. CCT: Correlated color temperature; a measure of the chromaticity (yellowness or blueness) of a white light source, expressed as the absolute temperature in kelvins of a blackbody radiator having similar chromaticity.

C. CRI: Color rendering index; a unitless estimation of how accurately a white light source displays the colors of reflected surfaces.

D. CV: Coefficient of variation.

E. DMX512: Digital multiplex with 512 pieces of information.

F. LLF: Light-loss factor.

G. RGBA: Red, green, blue, and amber.

H. RGBW: Red, green, blue, and white.

I. SPD: Surge protective device.

J. UG: Uniformity gradient.

K. UGR: Unified glare rating.

1.3 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals:

1. Engage qualified lighting design professional to design athletic field lighting equipment.
2. Engage qualified electrical professional engineer to design power distribution for athletic field lighting equipment.
3. Engage qualified structural professional engineer to design poles, hangers, and supports for athletic field lighting equipment.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For athletic field lighting. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Complete ordering information for luminaire, lamps, and accessories.
3. Data on features, accessories, and finishes.
4. Physical description and dimensions of luminaires.
5. Ballast, including UL listing and recognition, ANSI certification, and Energy Independence and Security Act of 2007 compliance.
6. Lamps, including life, output (lumens, CCT, and CRI), and energy-efficiency data.
7. Photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each lighting luminaire type. Adjustment factors must be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
8. Photoelectric relays.

9. Means of attaching luminaires to supports and indication that attachment is suitable for components involved.
10. Include sample warranty language.
11. Product Certificates:

    a. For each type of bilevel and dimmer-controlled luminaire ballast, signed by product manufacturer.
    b. For support structures, including brackets, arms, appurtenances, bases, anchorages, and foundations, signed by product manufacturer.

B. Shop Drawings: Prepare and submit the following:

1. Drawings, Diagrams, and Supporting Documents for Nonstandard or Custom Luminaire:

    a. Include plans, elevations, sections, and mounting and attachment details.
    b. Details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    c. Diagrams for power, signal, and control wiring.
    d. <**Insert additional requirements for drawing content or format**>.

C. Delegated Design Submittals: Include analysis data signed by delegated design professional(s) responsible for their preparation.

1. Drawings and specifications for construction of lighting system.
2. Manufacturer's determination of LLF used in design calculations.
3. Lighting system design calculations for the following:

    a. Target illuminance.
    b. Point calculations of horizontal and vertical illuminance, CV, and UG at minimum grid size and area.
    c. Point calculations of horizontal and vertical illuminance in indicated areas of concern for spill light.
    d. Calculations of source intensity of luminaires observed at eye level from indicated properties near the playing fields.

4. Luminaire layout and aiming diagrams.
5. Electrical system design calculations for the following:

    a. Short-circuit current calculations for rating of panelboards.
    b. Total connected and estimated peak-demand electrical load, in kilowatts, of lighting system.
    c. Capacity of [**feeder**][**service**] required to supply lighting system.

6. Electrical wiring diagrams, including required conductors, cables, and wiring methods.
7. Electrical riser diagrams.
8. Structural analysis data and calculations used for the following:

    a. Pole selection.
    b. Luminaire mounting arrangement.

D. Field quality-control reports.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

1.7 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Consumable items.

1.9 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

D. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

E. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic-load and wind-load controls, utility poles, equipment hangers and supports, and concrete foundations.

F. Lighting Design Professional: Design professional possessing active qualifications in accordance with Section 014000 "Quality Requirements" and the following:

1. Expertise in lighting design.
2. Lighting Certified (LC) Professional by the National Council on Qualifications for the Lighting Professions (NCQLP).

G. Exterior Athletic Lighting Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by exterior athletic lighting manufacturer prior to starting installation.

H. Outdoor Pole Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience in accordance with ASTM C1093 for foundation testing and inspections.

I. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.11 WARRANTY FOR ATHLETIC FIELD LIGHTING

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed athletic field lighting and associated electrical equipment perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**][**20**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.
2. Alignment Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.

    a. Accuracy of alignment of luminaires must remain within specified illuminance uniformity ratios.
    b. Realign luminaires that become misaligned during the warranty period.
    c. Replace alignment products that fail within the warranty period.
    d. Verify successful realignment of luminaires by retesting as specified in "Field Quality Control of Athletic Field Lighting" Article.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that athletic field lighting and associated electrical equipment perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Luminaire Extended-Warranty Period: [**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only free on board [**origin**][**destination**], freight prepaid.
2. Lamps and Fuses Extended-Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Description: <**Insert brief description of desired athletic field lighting system**>.

B. Performance Criteria:

1. Regulatory Requirements:

a. Components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. <**Insert requirements**>.

2. General Characteristics:

a. Facility Type: [**Professional**][**College**][**Semiprofessional**][**Sports club**][**Amateur league**][**High school**][**Training facility**][**Elementary school**][**Recreational or social facility**].
b. Glare Control: Design illumination for each playing area to minimize direct glare in adjacent and nearby areas.

1) Design source intensity of luminaires that may be observed at an elevation of **60 inch (1524 mm)** above finished grade from nearby properties to be less than [**12 000 cd**][**20 000 cd**][**30 000 cd**]<**Insert candela**> when so observed.
2) Design source intensity of luminaires that may be observed at an elevation of **60 inch (1524 mm)** above finished grade from designated "spill-light critical" areas to be less than [**12 000 cd**][**20 000 cd**][**30 000 cd**]<**Insert candela**> when so observed.

c. Egress Lighting: In case of power failure, provide not less than [**1.0 fc (10.8 lx)**]<**Indicate value**> average illumination, within 30 seconds, measured at grade in spectator and spectator egress areas.

1) Duration of emergency illumination must be not less than [**15 min**]<**Insert time**>.
2) Momentary Power Interruptions: Provide emergency illumination immediately following restoration of power to the lighting circuits. Emergency illumination must automatically extinguish after [**15 min**]<**Insert time**>.

d. Lighting Control: Manual, low voltage, or digital; providing the following functions, integrated into a single control station, with multiple subcontrol stations as indicated:

1) Control Station: Key-operated master switch, manual push-button controls, and system status indicator lights.[**Test switch of egress lighting system.**]
2) Light Levels: Two levels of control - [**100/50 percent**]<**Insert two percentages**> of minimum target illumination.
3) <**Insert Project-specific control requirements**>.

e. Electric Power Distribution Requirements:

1) Electric Power: [**208 V**][**240 V**][**480 V**]; three phase.

a) Include roughing-in of service indicated for nonsports improvements on the Project site.
b) Balance load between phases. Install wiring to balance three phases at each support structure.
c) Include required overcurrent protective devices and individual lighting control for each sports field or venue.
d) Include indicated feeder capacity and panelboard provisions for future lighted sports field construction.

2) Maximum Total Load: <**Insert number**> A.
3) Maximum Total Voltage Drop from Source to Load: [**5 percent**]<**Insert percentage**>, including voltage drops in branch circuit, subfeeder, and feeder.

3. Illumination Criteria: Calculate by computer-analyzed point method complying with IES RP-6 to optimize selection, location, and aiming of luminaires.

a. Minimum average target illuminance level for each lighted area for each sports venue and for the indicated class of play in accordance with IES RP-6.
b. CV and maximum-to-minimum uniformity ratios for each lighted area equal to or less than those listed in IES RP-6 for the indicated class of play.
c. UG levels within each lighted area equal to or less than those listed in IES RP-6 for the indicated speed of sport.
d. Minimum Average Target Illumination: <**Insert fc or lx**>.
e. CV: <**Insert value**>.
f. Maximum-to-Minimum Uniformity Ratio: <**Insert value**>.
g. UG Level: <**Insert value**>.
h. Grid Pattern Dimensions: For playing areas of each sport and areas of concern for spill-light control, correlate and reference calculated parameters to the grid areas. Each grid point represents the center of the grid area defined by the length and width of the grid spacing.
i. Spill-Light Control: Minimize spill light for each playing area on adjacent and nearby areas.

1) Prevent light trespass on properties near the Project as defined by <**Insert name(s) of authorities having jurisdiction**>.
2) For areas indicated on the Drawings as "spill-light critical," limit the level of illuminance directed into the area from any luminaire or group of luminaires, and measured **36 inch (914 mm)** above grade to the following:

a) Maximum Horizontal Illuminance: [**0.25 fc (2.7 lx)**][**0.5 fc (5.4 lx)**][**0.75 fc (8.1 lx)**].
b) Maximum Vertical Illuminance from the Direction of the Greatest Contribution of Light: [**1.0 fc (10.8 lx)**][**2.0 fc (21.5 lx)**][**3.0 fc (32.3 lx)**].

3) Calculate the horizontal and vertical illuminance due to spill light for points spaced [**20 ft (6 m)**]<**Insert dimension**> apart in areas indicated on the Drawings as "spill-light critical," to ensure that design complies with the above limits.

j. Determine LLF in accordance with IES RP-6 and manufacturer's test data.

1) Use LLF at [**100 percent**]<**Insert percentage**> of rated lamp life. LLF must be applied to initial illumination to ensure that target illumination is achieved at 100 percent of lamp life and must include consideration of field factor.
2) LLF must not be higher than 70 percent and may be lower when determined by manufacturer after application of the ballast output and optical system output, in accordance with IES RP-6.

k. Luminaire-Mounting Height: Comply with IES RP-6[**, with consideration for requirements to minimize spill light and glare**].
l. Luminaire Placement: Luminaire clusters must be outside the glare zones defined by IES RP-6.
m. Baseball Fields:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **30 by 30 ft (9 by 9 m)**.

n. Softball Fields:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **20 by 20 ft (6 by 6 m)**.

o. Football Fields:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **30 by 30 ft (9 by 9 m)**.

p. Soccer Fields:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **30 by 30 ft (9 by 9 m)**.

q. Outdoor Tennis Courts:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: **10 by 10 ft (3 by 3 m)**.

r. Insert Sport:

1) IES RP-6, Classes of Play: [**Class I**][**Class II**][**Class III**][**Class IV**].
2) Speed of Sport: [**Fast**][**Moderate**][**Slow**].
3) Grid Pattern Dimensions: <**Insert dimensions**>.

4. Life-Cycle Cost Criteria:

a. Estimated life-cycle cost of lighting system for period of <**Insert number**> years based on the parameters below:

1) Energy Cost: <**Insert dollars**>.
2) Lamp Replacement Cost: <**Insert dollars**>.
3) General Maintenance Cost: <**Insert dollars**>.

b. <**Insert life-cycle cost criteria**>.

2.2 ATHLETIC FIELD LUMINAIRES AND LAMPS

A. UL IFAM - LED Surface-Mounted Athletic Field Luminaire :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CHM Lighting**]
    b. [**Ephesus Sports Lighting; a brand of Cooper Lighting Solutions; Signify N.V.**]
    c. [**Musco Lighting**]
    d. [**Sportsbeams**]
    e. [**Sportsliter Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CHM Lighting**]
    b. [**Ephesus Sports Lighting; a brand of Cooper Lighting Solutions; Signify N.V.**]
    c. [**Musco Lighting**]
    d. [**Sportsbeams**]
    e. [**Sportsliter Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria:

    a. LED Surface-Mounted Luminaires: UL CCN IFAM; including UL 1598.
    b. LED Drivers: UL CCN FKSZ or UL CCN FKSZ2; including UL 8750.

5. Standard Features:

    a. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit servicing without using tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent their accidental falling during servicing and when secured in operating position. Doors must be removable for cleaning or replacing lens. Designed to disconnect driver when door opens.
    b. Finishes:

        1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
        2) Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and can be and are assembled or installed to minimize contrast.

    c. Exposed Hardware: Corrosion-resistant metal latches, fasteners, and hinges.
    d. Markings: "Suitable for Wet Locations."
    e. Luminaire Mounting: Bracket mounted.
    f. Driver Mounting: [**Remote; grouped in cabinets**][**Bracket mounted**][**Integral to luminaire; field changeable**].
    g. Driver Performance:

1) Nominal Input Voltage: [**120 V**][**208 V**][**240 V**][**277 V**][**480 V**], 60 Hz.
2) Nominal Input Power: [**80 W**][**100 W**][**150 W**][**300 W**][**500 W**][**1000 W**][**1200 W**][**1500 W**]<**Insert wattage**>.
3) Power Factor: Not less than [**0.90**]<**Insert power factor requirement**> lagging.
4) Total Harmonic Distortion: Not greater than [**16 percent**][**20 percent**]<**Insert percentage**>.

h. Beam Spread Pattern: [**NEMA Type 1 (very narrow)**][**NEMA Type 2 (narrow)**][**NEMA Type 3 (medium narrow)**][**NEMA Type 4 (medium)**][**NEMA Type 5 (medium wide)**][**NEMA Type 6 (wide)**][**NEMA Type 7 (very wide)**][**Narrow spot (2 deg H by 2 deg V)**][**Narrow flood (4 deg H by 4 deg V)**][**Horizontal flood (5 deg H by 3 deg V)**][**Vertical flood (3 deg H by 5 deg V)**][**Medium flood (5 deg H by 5 deg V)**][**Wide flood (6 deg H by 6 deg V)**]<**Insert _ deg H by _ deg V beam angles**>.

i. Light Color: [**White only**][**Tunable RGBW**][**Tunable RGBA**]<**Insert color requirement**>[**; designed for 4K/HDTV broadcasting**].

1) White Correlated Color Temperature: [**2700 to 3000 K**][**4000 K**][**5000 K**][**5700 to 6000 K**][**3000/4000/5000 K selectable**]<**Insert CCT kelvins**>.
2) White Color Rendering Index: [**70+**][**80+**][**90+**]<**Insert CRI**>.

j. Energy Efficiency: [**Premium**][**DLC listed**][**and**][**ENERGY STAR listed**].

6. Other Available Features Required by the Project:

a. Spill-Light Control Devices: Internal louvers and external baffles furnished by manufacturer and designed for secure attachment to specific luminaire.
b. Dimming: [**0-10 V dimmable**]<**Insert dimming requirement**>.
c. Dimming Range (Light Output): [**0-100 percent**][**10-100 percent or better**][**20-100 percent or better**]<**Insert dimming range requirement**>.
d. Dim to off.
e. Surge Protection: Provide integral Type 2 SPDs; nonmodular, with digital indicator lights[**and one set of dry contacts**].

1) Maximum SPD Discharge Current Rating: [**10 kA**][**20 kA**]<**Insert kA**> per phase.

f. Unified Glare Rating: [**Less than 22**][**Less than 19**]<**Insert UGR requirement**>.
g. Field-changeable lenses.
h. Luminaire Lighting Control Interface: [**TIA-485 jack for ESTA E1.11 DMX512 cable**][**Termination box for ESTA E1.11 DMX512 cable**][**8P8C jack for ESTA E1.31 ACN Ethernet cable**][**DALI driver**][**Wireless**] Open Lighting Alliance compliant interface.
i. Pre-terminated wiring pigtail.
j. 12 V secondary output power for external sensors, controls, or accessories.

2.3 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing sports lighting, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: [**One percent**]<**Insert percentage**> of each type and rating installed. Furnish at least one of each type.
2. Ballasts: [**One percent**]<**Insert percentage**> of each type and rating installed. Furnish at least one of each type.
3. Fuses: [**10 percent**]<**Insert percentage**> of each type and rating installed. Furnish at least one of

each type.

B. Consumable Items: Furnish to Owner extra consumable items for storage on-site, identified with labels describing contents.[**Include the following:**]

1. Lamps: [**10 percent**]<**Insert percentage**> of each type and rating installed. Furnish at least one of each type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical and communications conduit to verify actual locations of connections before pole or luminaire installation.

C. Examine foundations for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ATHLETIC FIELD LIGHTING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Life Safety and Means of Egress Work: NFPA 101.
5. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
6. Luminaires and Supports: Article 410 of NFPA 70.
7. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Athletic Field Luminaires, Lamps, and Ballasts:

a. Install luminaires at height and aiming angle as indicated on Drawings.
b. Install controls and ballast housings in cabinets mounted on support structure at least **10 ft (3 m)** above finished grade.

2. Structural Supports:

a. Provide [**steel**][**aluminum**][**concrete**] poles and other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations for athletic field lighting.
b. Use web fabric slings (not chain or cable) to raise and set structural members. Protect equipment during installation to prevent corrosion.
c. Install poles and other structural units level, plumb, and square.

d. Except for embedded structural members, grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space. Use a short piece of 1/2 inch (13 mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole. Nonshrink grout is specified in Section 055000 "Metal Fabrications."
e. Extend cast-in-place bolted base foundations 36 inch (914 mm) above grade, minimum.
f. Install protective pipe bollards on [**two**][**three**]<**Insert number**> sides of each embedded pole installed in paved areas.

3. Surge Protection: Install Type 2 surge protective devices; nonmodular, with digital indicator lights[**and one set of dry contacts**].

a. Peak Single-Impulse Surge Current Rating: <**Insert number**> kA per phase.

4. Wiring Methods:

a. Install cables in raceways, except when cables are installed within boxes and poles. Conceal raceways and cables.
b. Feeders, Subfeeders, Branch Circuits, and Control Wiring: Underground nonmetallic raceway; 10 AWG minimum conductor size for power wiring.
c. Overhead-, pole-, or structure-supported wiring and transformers are[**not**] permitted.
d. Electrical Enclosures Exposed to Weather: UL 50E, Type 3R enclosure constructed from [**stainless steel**][**corrosion-resistant material**], with hinged doors fitted with padlock hasps or lockable latches.
e. Install lighting control equipment and cabling connections to luminaires.

5. Identification: Provide labels for athletic field lighting and associated electrical equipment.

a. Identify system components and terminals.
b. Identify field-installed conductors, interconnecting wiring, and components.
c. Provide warning signs.
d. Label each enclosure with engraved metal or laminated-plastic nameplate.

6. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Section 260573 "Power System Studies" for mitigating available fault current and arc-flash hazard in electrical equipment installed for athletic field lighting.
3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

E. Systems Integration: Integrate athletic field lighting controls with facility lighting controls.

3.3 FIELD QUALITY CONTROL OF ATHLETIC FIELD LIGHTING

A. Administrant for Electrical Power Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Field Tests and Inspections of Lighting Installations:

1. [**Owner**][**Tenant**] will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. <**Insert requirements**>.

D. Field tests and inspections must be witnessed by [**Architect**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. After installing sports lighting system and after electrical circuits have been energized, perform proof-of-performance field measurements and analysis for compliance with requirements.
2. Playing and Other Designated Areas: Make field measurements at intersections of grids, dimensioned and located as specified in "Performance Requirements" Article and as described below:

    a. Baseball Fields: Measure at least [**25**]<**Insert number**> points of the infield and [**87**]<**Insert number**> points of the outfield. Extend the grid **15 ft (5 m)** outside the foul lines, extending to outfield boundary or fence.
    b. Softball Fields: Measure at least [**16**]<**Insert number**> points of the infield and [**48**]<**Insert number**> points of the outfield. Extend the grid **15 ft (5 m)** outside the foul lines, extending to outfield boundary.
    c. Football Fields: Lighted area is [**180 by 360 ft (55 by 110 m)**]<**Insert dimensions**>. Measure at least [**91**]<**Insert number**> points.
    d. Soccer Fields: Lighted area is [**210 by 370 ft (64 by 113 m)**]<**Insert dimensions**>. Measure at least [**91**]<**Insert number**> points.
    e. Outdoor Tennis Courts: Measure at least [**30**]<**Insert number**> points for a double court.
    f. <**Insert sports venue**>: Measure at least <**Insert number**> points.

3. Make field measurements at established test points in areas of concern for spill light and glare.
4. Perform analysis to demonstrate correlation of field measurements with specified illumination quality and quantity values and corresponding computer-generated values that were submitted with engineered design documents. Submit a report of the analysis. For computer-generated

values, use manufacturer's lamp lumens that are adjusted to lamp age at time of field testing.

5. Report results in writing.

F. Nonconforming Work:

1. Sports lighting will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.
3. Correction of Illumination Deficiencies for Playing Areas: Make corrections to illumination quality or quantity, measured in field quality-control tests, that varies from specified illumination criteria by plus or minus 10 percent.

    a. Add or replace luminaires; change mounting height and aiming; or install louvers, shields, or baffles.
    b. If luminaires are added or mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
    c. Do not replace luminaires with units of higher or lower wattage without Architect's approval.
    d. Retest as specified above after repairs, adjustments, or replacements are made.
    e. Report results in writing.

G. Correction of Excessive Illumination in Spill-Light-Critical Areas: If measurements indicate that specified limits for spill light are exceeded, make corrections to illumination quantity, measured in field quality-control tests, that reduce levels to within specified maximum values.

1. Replace luminaires; change mounting heights and revise aiming; or install louvers, shields, or baffles.
2. Obtain Architect's approval to replace luminaires with units of higher or lower wattage.
3. If mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
4. Retest as specified above after repairs, adjustments, or replacements are made.

H. Assemble and submit test and inspection reports.

I. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.4 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.5 ADJUSTING

A. Adjust luminaires and supports to maintain orientation and aiming as recommended by manufacturer.

B. Luminaire Aiming Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting aiming direction of luminaires to suit occupied conditions. Make up to [**two**]<**Insert number**> visits to the Project site during other-than-normal hours for this purpose. Some of the Work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
3. Adjust aim of luminaires in presence of Architect.

3.6 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**][**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain luminaires[**and lighting controls**].

3.7 PROTECTION

A. After installation, protect athletic field lighting and associated electrical equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of athletic field lighting Installer**][**manufacturer's authorized service representative**]. Include [**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper athletic field lighting operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

END OF SECTION 26 55 68 00

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Task	Specification	Specification Description
26 55 68 00	26 50 00 00	Lighting
26 56 00 00	26 50 00 00	Lighting
26 56 13 00	02 41 19 00	Selective Demolition
26 56 13 00	26 50 00 00	Lighting
26 56 18 00	26 50 00 00	Lighting
26 56 19 00	26 50 00 00	Lighting
26 56 21 00	26 50 00 00	Lighting
26 00 00 00MOD000	26 01 00 00	Supplemental Requirements for Electrical

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SECTION 27 11 00 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications-circuit accessories.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> for preinstallation conference procedures.
5. Section 061000 "Rough Carpentry" furnishes equipment backing panels installed by this Section.
6. Section 260526 "Grounding and Bonding for Electrical Systems" specifies the following installed by this Section:

    a. Grounding and bonding conductors.
    b. Grounding and bonding clamps.
    c. Grounding and bonding bushings.
    d. Grounding and bonding hubs.
    e. Grounding and bonding connectors.
    f. Intersystem bonding bridge grounding connector.
    g. Grounding and bonding busbars.
    h. Signal reference grids.

7. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases for communications equipment installed by this Section.
8. Section 260533.16 "Boxes and Covers for Electrical Systems" furnishes the following installed by this Section:

    a. Metallic outlet boxes, device boxes, rings, and covers.
    b. Junction boxes and pull boxes.
    c. Cover plates for device boxes.

9. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-control devices referenced by this Section.
10. Section 260553 "Identification for Electrical Systems" specifies labels and warning signs for communications pathways installed by this Section.
11. Section 262716 "Electrical Cabinets and Enclosures" specifies the following installed by this Section:

    a. Cabinets and cutout boxes.
    b. Termination boxes.
    c. Miscellaneous enclosures.

d. Rack or frame systems.
e. Enclosure-mounted relocatable power taps.

12. Section 262719 "Multi-Outlet Assemblies" specifies the following installed by this Section:

a. Wall-mounted, surface metal raceway multi-outlet assemblies.
b. Indoor service poles.

13. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" specifies duplex receptacles installed by this Section.
14. Section 262726.39 "Locking Receptacles" specifies locking receptacles installed by this Section.
15. Section 262726.51 "Connectors, Cords, and Plugs" specifies pendant flexible cords and connectors installed by this Section.
16. Section 270528 "Pathways for Communications Systems" specifies cable pathways serving communications equipment room fittings installed under this Section.

1.2 DEFINITIONS

A. Abbreviations for Communications Spaces:

1. EF: Entrance facility; generally serves campus or building. EF may include an ER.
2. ER: Equipment room; generally serves campus or building.
3. TE: Telecommunications enclosure; generally serves a single tenant or floor.
4. TR: Telecommunications room; generally serves a single tenant or floor.

B. Abbreviations for Communications Facilities:

1. HC: Horizontal cross-connect; also called "floor distributor" (FD).
2. IC: Intermediate cross-connect; also called "building distributor" (BD).
3. MC: Main cross-connect; also called "campus distributor" (CD).

C. Abbreviations for Grounding and Bonding:

1. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
2. PBB: Primary bonding busbar; located in main distribution frame room, ideally near electrical service entrance.
3. RBB: Rack bonding busbar; located in equipment cabinets and racks.
4. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
5. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
6. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
7. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
8. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For communications equipment room planning. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Representative of Owner's information and communications technology staff[**that will be installing electronic equipment**][**and cables**], installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Communications Equipment Room Drawings, Diagrams, and Supporting Documents:

a. Include plans, elevations, sections, details, and attachments to other work.
b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Equipment Racks and Cabinets: Indicate workspace requirements and access for cable connections.
d. Switchboards, Panelboards, and Safety Switches: Indicate workspace requirements and access for cable connections.
e. Grounding and Bonding: Indicate location of busbars and their mounting details showing standoff insulators and wall mounting brackets.
f. Cable Trays, Large Raceways, Ducts, and Piping: Indicate elevation and route of vertical and horizontal cable trays, raceways or ducts larger than **2 inch (50 mm)** wide, and fire-suppression piping located inside communications equipment room.
g. Luminaires: Indicate elevation, orientation, and size of luminaires inside the communications equipment room for coordination with cable trays, equipment racks, cabinets, and other equipment.
h. Access Panels: Indicate locations, dimensions, and clearances required to open access panels in ducts, walls, or ceilings inside communications equipment room.
i. Controls: Indicate locations of sensors, switches, and push-buttons for HVAC, fire suppression, fire alarm, and standby power.
j. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
k. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
l. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician [**III**][**IV**] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**, and unit must be fully operational after seismic events**].
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

2.2 COMMUNICATIONS-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for connecting communications circuits in accordance with Article 800 of NFPA 70.

B. UL DUXR - 66-Style or 110-Style Cross-Connect Frame :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Canada ULC**]
b. [**CommScope, Inc**]
c. [**Optical Cable Corporation (OCC)**]
d. [**Ortronics, Inc.**]
e. [**Panduit Corp**]
f. [**Siemon Co. (The)**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Canada ULC**]
b. [**CommScope, Inc**]
c. [**Optical Cable Corporation (OCC)**]
d. [**Ortronics, Inc.**]
e. [**Panduit Corp**]
f. [**Siemon Co. (The)**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. For Communications Circuits: UL CCN DUXR; including UL 1863 and UL 467.
b. For Audio/Video, Data, and Signaling Circuits: UL CCN DUXR; including UL 1977 and UL 467.

5. Standard Features: This product type includes the frame only. Block inserts and related termination equipment are specified in communications cabling Sections.

C. UL DUXR - Patch Panel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Legrand AV Inc.; Legrand North America, LLC**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Ortronics, Inc.**]
f. [**Panduit Corp**]
g. [**Pass & Seymour; Legrand North America, LLC**]
h. [**Siemon Co. (The)**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]

b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Legrand AV Inc.; Legrand North America, LLC**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Ortronics, Inc.**]
f. [**Panduit Corp**]
g. [**Pass & Seymour; Legrand North America, LLC**]
h. [**Siemon Co. (The)**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. For Communications Circuits: UL CCN DUXR; including UL 1863 and UL 467.
   b. For Audio/Video, Data, and Signaling Circuits: UL CCN DUXR; including UL 1977 and UL 467.

5. Standard Features:

   a. Mounting: [**Equipment rack**][**Wall**].
   b. Style: [**Modular**][**Prepopulated 110 punch down**].
   c. EMI Compatibility: [**Shielded**][**Unshielded**].
   d. Configuration: [**Standard**][**High density**]; [**flat**][**angled**].
   e. Include provisions for labeling ports.
   f. Distribution Port Quantity: [**12**][**24**][**48**][**72**][**144**]<**Insert quantity**>.
   g. Cable Type: [**Cat. 5e**][**Cat. 6**][**Cat. 6a**][**Optical fiber**]<**Insert cable type**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Grounding and Bonding Conductors:

1. Communications Busbar Connections:

   a. TBC: Not smaller than [**1/0 AWG**][**3/0 AWG**]<**Insert wire size**> and no smaller than largest TBB.
   b. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
   c. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
   d. TEBC: Not smaller than [**2 AWG**]<**Insert wire size**> unless otherwise indicated on Drawings. Provide bolted connectors.
   e. UBC: Not smaller than [**6 AWG**]<**Insert wire size**> unless otherwise indicated on

Drawings. Provide bolted connectors.

f. Bonding Conductors to Structural Steel: Not smaller than [**6 AWG**]<**Insert wire size**> unless otherwise indicated on Drawings. Provide bolted clamp connectors.

2. Cable Tray Connections:

a. Cable Tray Equipment Grounding Conductor: [**8 AWG**][**6 AWG**][**4 AWG**].
b. Cable Tray Bonding Jumper: If not supplied by cable manufacturer, provide bonding jumper not smaller than [**10 AWG**][**6 AWG**] and not longer than **12 inch (300 mm)**. If jumper is wire, it must be terminated with lug having [**one hole and standard barrel for one crimp**][**two holes and long barrel for two crimps**]. If jumper is flexible braid, it must be terminated with [**one- or two-hole ferrule**][**one-hole ferrule**]. Attach with bonding screw or connector provided by cable tray manufacturer.

3. Underground Connections: Not smaller than [**2 AWG**]<**Insert wire size**>. Provide welded connectors, except bolted connectors may be used in handholes or manholes and as otherwise indicated on Drawings.

B. Grounding and Bonding Busbars:

1. PBB:

a. Dimensions: [**1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high)**]<**Insert dimensions**>.
b. Stand-Off Distance: [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**>.

2. SBB:

a. Dimensions: [**1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high)**]<**Insert dimensions**>.
b. Stand-Off Distance: [**2 inch (50 mm)**][**4 inch (100 mm)**]<**Insert dimension**>.

C. Access Floor Signal Reference Grid:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing [**6 AWG**]<**Insert wire size**> bonding conductors in a grid pattern under the floor.

a. Install grid bonding conductors on **4 ft (1200 mm)** centers, so as to permit bonding of one structural pedestal for each access floor tile. Connect grid conductors together where they cross each other.
b. Bond SBBs in room to two or more bonding conductors of reference grid with TEBCs.
c. Bond equipment to nearest SBB and to reference grid with TEBCs.
d. Bond conduits and piping entering equipment room with TEBCs to nearest SBB and to grid conductor nearest entry into room.

D. Signal Reference Grid Wire Mesh:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing wire mesh [**in concrete floor slab**][**above ceiling**] with the following features:

a. Wire mesh, 10 AWG solid copper, **2 inch (50 mm)** spacing.
b. Wire mesh, 10 AWG solid copper, **3 inch (75 mm)** spacing.
c. Wire mesh, 10 AWG solid copper, **4 inch (100 mm)** spacing.
d. Wire mesh, 10 AWG solid copper, **6 inch (150 mm)** spacing.

e. Wire mesh, 10 AWG solid copper, **12 inch (300 mm)** spacing.
f. Wire mesh, 8 AWG solid copper, **4 inch (100 mm)** spacing.
g. Wire mesh, 8 AWG solid copper, **6 inch (150 mm)** spacing.
h. Wire mesh, 8 AWG solid copper, **8 inch (200 mm)** spacing.
i. Wire mesh, 8 AWG solid copper, **12 inch (300 mm)** spacing.
j. Wire mesh, 6 AWG solid copper, **4 inch (100 mm)** spacing.
k. Wire mesh, 6 AWG solid copper, **6 inch (150 mm)** spacing.
l. Wire mesh, 6 AWG solid copper, **8 inch (200 mm)** spacing.
m. Wire mesh, 6 AWG solid copper, **12 inch (300 mm)** spacing.
n. Wire mesh, 6 AWG solid copper, **24 inch (610 mm)** spacing.
o. Wire mesh, 4 AWG solid copper, **4 inch (100 mm)** spacing.
p. Wire mesh, 4 AWG solid copper, **6 inch (150 mm)** spacing.
q. Wire mesh, 4 AWG solid copper, **12 inch (300 mm)** spacing.
r. Wire mesh, 2 AWG solid copper, **4 inch (100 mm)** spacing.
s. Wire mesh, 2 AWG solid copper, **6 inch (150 mm)** spacing.
t. Wire mesh, 2 AWG solid copper, **12 inch (300 mm)** spacing.
u. Wire mesh, 2 AWG solid copper, **24 inch (610 mm)** spacing.

E. Signal Reference Grid Tape Mesh:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing tape mesh under floor finish with the following features:

a. Wire mesh, **2 inch (50 mm)** by **16 mil (0.4 mm)** solid copper, **12 inch (300 mm)** spacing.
b. Wire mesh, **2 inch (50 mm)** by **16 mil (0.4 mm)** solid copper, **24 inch (610 mm)** spacing.

3.3 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection[**and fire-alarm**] equipment[**, including raceways,**] must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than [**7.7 ft (2.3 m)**]<**Insert height**> above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1[**and IEEE C2**].

C. Color Coding Scheme for Communications Cable and Terminations: Comply with BICSI N1 and TIA-598.

D. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "COMMUNICATIONS."
2. "FIRE ALARM."
3. "SECURITY."
4. <**Insert name**>.

E. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

F. Locations of Underground Lines: Underground-line warning tape for communication, control wiring, and optical-fiber cable.

G. Communications Vaults, Manholes, Handholes, and Pull and Junction Boxes: For conductors in vaults, pull and junction boxes, manholes, and handholes, use [**vinyl wraparound labels**][**self-adhesive wraparound labels**][**snap-around labels**][**snap-around color-coding bands**][**self-adhesive vinyl tape**] to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft (15 m)** maximum intervals in straight runs, and at **25 ft (7.6 m)** maximum intervals in congested areas.

H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use [**write-on tags**][**self-adhesive labels**] with conductor or cable designation, origin, and destination.

I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide [**heat-shrink preprinted tubes**][**self-adhesive labels**] with conductor designation.

J. Conductors to Be Extended in Future: Attach [**write-on tags**][**marker tape**] to conductors[**and list source**].

K. Auxiliary Electrical Systems Conductor Identification: [**Marker tape**][**Self-adhesive vinyl tape**] that is uniform and consistent with system used by manufacturer for factory-installed connections.

L. Equipment and Cabling Identification for Administrative Records and Labeling: Comply with TIA-606 requirements for [**Class 1**][**Class 2**][**Class 3**][**Class 4**] network administration.

M. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: [**Self-adhesive label**][**Baked-enamel signs**][**Metal-backed butyrate signs**][**Laminated acrylic or melamine plastic sign**].
3. Outdoor Equipment: [**Laminated acrylic or melamine sign**][**Stenciled legend 4 inch (100 mm) high**].
4. Equipment to Be Labeled:

    a. Racks, Frames, and Enclosures: Identify front and rear of each enclosure with self-adhesive labels[**containing equipment designation**].
    b. Patch Panels: [**Label individual rows in each rack, starting at top and working down, with self-adhesive labels.**][**Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.**]
    c. Communications cabinets.
    d. Access doors and panels for concealed communications items.
    e. Emergency system boxes and enclosures.
    f. Contactors.
    g. Remote-controlled switches, dimmer modules, and control devices.
    h. Monitoring and control equipment.
    i. Fire-alarm equipment.
    j. Security equipment.
    k. Life-safety communications equipment.
    l. <**Insert equipment**>.

N. Backbone Cables: Label each cable with a [**vinyl-wraparound label**][**snap-around label**][**self-adhesive wraparound label**] indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

O. Horizontal Cables: Label each cable with a [**vinyl-wraparound label**][**snap-around label**][**self-adhesive wraparound label**].

P. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Identify cover plate in accordance with TIA-606.

Q. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.4 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT/RACK HAS MULTIPLE POWER SOURCES."
2. <**Insert names and wording of warning signs or labels**>.

D. Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**].

E. Emergency Operating Instruction Signs: [**Self-adhesive labels**][**Baked-enamel warning signs**][**Metal-backed, butyrate warning signs**][**Laminated acrylic or melamine plastic signs**] with white legend on red background with minimum **3/8 inch (10 mm)** high letters for emergency instructions at equipment used for <**Insert emergency operations**>.

F. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.5 INSTALLATION OF FITTINGS FOR ENTRANCE FACILITY

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.
3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in entrance facility room or space as indicated on Drawings:

1. Equipment backing panel .

a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is

fire treated, ensure that fire-treatment stamp is visible after installation.

2. PBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 66-style or 110-style cross-connect frame .
10. Patch panel .

3.6 INSTALLATION OF FITTINGS FOR EQUIPMENT ROOM

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.
3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in entrance facility room or space as indicated on Drawings:

1. Equipment backing panel .

    a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is fire treated, ensure that fire-treatment stamp is visible after installation.

2. PBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 110-style cross-connect frame .
10. Patch panel .

3.7 INSTALLATION OF FITTINGS FOR TELECOMMUNICATIONS ROOMS

A. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Designated Critical Operations Areas: Comply with Article 708 of NFPA 70.
2. Communications Systems: Comply with Ch. 8 of NFPA 70 and with BICSI N1.

3. Grounding and Bonding: Comply with Article 250 of NFPA 70 and with BICSI N3.
4. Consult Architect for resolution of conflicting requirements.

B. Provide the following specified products in intermediate distribution frame room or space as indicated on Drawings:

1. Equipment backing panel .

   a. Install from **6 inch (150 mm)** to **8 ft, 6 inch (2588 mm)** above finished floor. If plywood is fire treated, ensure that fire-treatment stamp is visible after installation.

2. SBB .
3. NEMA 5-20R [**isolated ground,**][**extra-heavy-duty,**]<**Insert description**> duplex straight-blade receptacle, outlet box, and cover plate .
4. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> locking receptacle, outlet box, and cover plate .
5. [**NEMA L5-20R**][**NEMA L6-20R**][**NEMA L14-20R**][**, isolated ground,**]<**Insert description**> pendant, extra-hard-usage, jacketed, flexible cord and connector .
6. Surface-mounted multi-outlet assembly .
7. Indoor service pole .
8. [**19 inch open**][**19 inch enclosed**][**23 inch open**][**23 inch enclosed**] equipment rack with RBB and enclosure-mounted relocatable power tap .
9. 110-style cross-connect frame .
10. Patch panel .

3.8 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Grounding of Communications: Bond PBB and SBBs to grounding electrode conductors at electrical power service entrance, and at electrical power derived systems serving communications equipment, using intersystem bonding termination device.

1. Structural Steel: Where structural steel of steel frame building is readily accessible within room or space, bond each SBB and PBB to vertical steel of building frame.

B. Comply with manufacturer's published instructions.

C. Reference Standards:

1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
2. Consult Architect for resolution of conflicting requirements.

D. Special Techniques:

1. Bonding of Busbars:

   a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers **12 inch (300 mm)** above finished floor unless otherwise indicated.
   b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

2. Bonding Conductors:

a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:

1) Use crimping tool and die specific to connector.
2) Pretwist conductor.
3) Apply antioxidant compound to bolted and compression connections.

c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
d. Install without splices.
e. Support conductors at not more than **36 inch (900 mm)** intervals.
f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-A or EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.

1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing and bond both ends of raceway to SBB.

3. Provide TBC and terminate ends to PBB and intersystem bonding [**termination device**][**busbar**] at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.
4. Busbar Interconnections: Bond SBBs to PBB with TBBs. If more than one TBB is installed, bond TBBs together with BBCs where required by TIA-607.
5. Communications Enclosures: Bond metallic enclosures of telecommunications equipment with UBCs to nearest SBB or PBB.
6. Equipment Racks: Bond metallic components of enclosures to RBB using UBCs. Provide [**top-mounted**][**vertically mounted**] RBB if not provided by enclosure or rack manufacturer. Bond RBB to SBB with TEBC. Power connection must comply with NFPA 70; equipment grounding conductor in power cord of cord- and plug-connected equipment must be considered supplemental to bonding requirements in this Section.
7. Shielded Cable: Bond shield of shielded cable to SBB in communications rooms and spaces. Comply with TIA-568.1 and TIA-568.2 when grounding shielded balanced twisted-pair cables.
8. Primary Protector: Bond to PBB with insulated bonding conductor.
9. Electrical Power Panelboards: Where electrical panelboards for communications equipment are located in same room or space, bond each ground bar of panelboard to SBB.
10. Cable Trays: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
11. Ladder Racks: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
12. Access Floors: Bond metal parts of access floors to SBB.
13. <**Insert connections for other equipment**>.

3.9 FIELD QUALITY CONTROL FOR BONDING OF COMMUNICATIONS

A. Administrant for Grounding and Bonding Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections

on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.

a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 mΩ.

1) If measured resistance from electrical service equipment to ground exceeds [**5 Ω**]<**Insert resistance**>, notify Architect and include recommendations to reduce resistance to ground.

b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 mΩ.

3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.

a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB[**and to SBBs**]. Maximum acceptable AC current level is 1 A.

E. Nonconforming Work:

1. Communications bonding will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

3.10 PROTECTION

A. After installation, protect communications equipment room fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 27 11 00 00

Task	Specification	Specification Description
27 11 16 00	27 11 00 00	Communications Equipment Room Fittings
27 11 19 00	27 11 00 00	Communications Equipment Room Fittings
27 11 19 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 11 23 00	27 11 00 00	Communications Equipment Room Fittings

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SECTION 27 13 13 00 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backbone communications cables.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Products Furnished, but Not Installed, under This Section:

1. <**Insert products furnished, but not installed**>.

C. Products Installed, but Not Furnished, under This Section:

1. See Section 270553 "Identification for Communications Systems" for communications equipment labels.
2. See Section 271513 "Communications Copper Horizontal Cabling" for Type CM, CMG, and CMX cabling.

D. Related Requirements:

1. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 270010 "Supplemental Requirements for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.3 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.4 DEFINITIONS

A. Cable Types:

1. FTP: Foil shielded twisted pair.
2. F/FTP: Bundle of FTP cables with overall foil shield.
3. F/UTP: Bundle of UTP cables with overall foil shield.
4. S/FTP: Bundle of FTP cables with overall braided shield.
5. S/UTP: Bundle of UTP cables with overall braided shield.
6. UTP: Unshielded twisted pair.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

1.5 SEQUENCING

A. Wet-work in spaces must be completely dry, and HVAC system must be operating and maintaining ambient temperature and humidity conditions within manufacturer's recommended limits, before delivering and installing cables and connecting materials.

1.6 ACTION SUBMITTALS

A. Product Data:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Shop Drawings:

1. Cable labeling schedules.
2. Cabling administration diagrams.
3. Wiring diagrams.
4. Cross-connect and patch panel details.
5. Twisted-pair cable testing plan.

C. Field quality-control reports.

D. Sustainable design submittals.

1. Backbone communications cable.

1.7 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Field Reports:

1. Factory Test Reports:

a. Backbone communications cable.

1.8 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: For communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Special Tools: For communications-, audio/video-, data-, and other signaling-circuit accessories.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted-pair cable for open and short circuits.

1.11 WARRANTY FOR COMMUNICATIONS COPPER BACKBONE CABLE ASSEMBLIES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed communications copper backbone cable assemblies perform in accordance with specified requirements and agrees to repair or replace cable assemblies that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 BACKBONE COMMUNICATIONS CABLES

A. Description: This category covers multiple conductor jacketed communications cable for telephone and other communications circuits for use in risers and plenums as described in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Certified Cable: UL CCN DUZX; including UL 444.
b. Verified Cable: UL CCN DVBI; including TIA-568.2.
c. Type CMP: NFPA 262.
d. Type CMR: UL 1666.
e. Limited Smoke: Marked "-LS" in accordance with UL 1685.
f. Halogen-Free: Marked "-HF" in accordance with UL Subject 2885.
g. Low Smoke and Halogen-Free: Marked "-LSHF" in accordance with IEC 61034-2.
h. Cable Heating Test: Marked "-LP" with current rating and temperature rating.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Sustainable Design Submittals: Prepare and submit documentation for the following:

    a. Product Data: For each conductor and cable indicating lead content of less than 300 parts per million.
    b. Environmental Product Declaration: For each product.
    c. Health Product Declaration: For each product.
    d. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
    e. Third-Party Certifications: For each product.
    f. Third-Party Certified Life Cycle Assessment: For each product.

3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
4. Factory Tests:

    a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
    b. Testing Administrant: [**Owner will engage**][**Engage**] qualified electrical testing agency to evaluate cable reels.
    c. Factory Tests and Inspections: Test and inspect cable on reels, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-568.2 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.
    d. Nonconforming Work:

        1) Cable reels that do not pass tests and inspections will be considered defective.

    e. Factory Test Reports: Prepare and submit factory test and inspection reports.

D. UL DUZX and DVBI - Type CMP, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CommScope, Inc**]
    b. [**Hitachi Cable America Inc.**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Molex Premise Networks**]
    f. [**Panduit Corp**]
    g. [**Prysmian Cables and Systems; Prysmian Group North America**]
    h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    i. [**West Penn Wire; brand of Belden, Inc.**]
    j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CommScope, Inc**]
    b. [**Hitachi Cable America Inc.**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell**

Incorporated]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

3. Product Marking: Type CMP; Category 3.
4. Options:

a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket:
[**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

E. UL DUZX and DVBI - Type CMP, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. [**West Penn Wire; brand of Belden, Inc.**]
j. <**Insert manufacturer's name**>

F. UL DUZX and DVBI - Type CMP, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Product Marking: Type CMP; Category 6.
4. Options:

a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

G. UL DUZX and DVBI - Type CMP, Category 6A Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Molex Premise Networks**]
e. [**Panduit Corp**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Molex Premise Networks**]
e. [**Panduit Corp**]
f. [**Prysmian Cables and Systems; Prysmian Group North America**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Product Marking: Type CMP; Category 6A.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

H. UL DUZX and DVBI - Type CMR, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. [**West Penn Wire; brand of Belden, Inc.**]
l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]

k. [**West Penn Wire; brand of Belden, Inc.**]
l. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 3.
4. Options:

a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket:
[**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

I. UL DUZX and DVBI - Type CMR, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Leviton Manufacturing Co., Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Molex Premise Networks**]
h. [**Panduit Corp**]
i. [**Prysmian Cables and Systems; Prysmian Group North America**]
j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
k. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 5e.
4. Options:

a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

J. UL DUZX and DVBI - Type CMR, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Mohawk; a division of Belden Networking, Inc.**]
    g. [**Molex Premise Networks**]
    h. [**Panduit Corp**]
    i. [**Prysmian Cables and Systems; Prysmian Group North America**]
    j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    k. [**TE Connectivity Ltd.**]
    l. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. [**Mohawk; a division of Belden Networking, Inc.**]
    g. [**Molex Premise Networks**]
    h. [**Panduit Corp**]
    i. [**Prysmian Cables and Systems; Prysmian Group North America**]
    j. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    k. [**TE Connectivity Ltd.**]
    l. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 6.
4. Options:

    a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
    b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
    c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

K. UL DUZX and DVBI - Type CMR, Category 6A Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]

d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 6A.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

L. UL DUZX and DVBI - Type CMR, Category 8 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR; Category 8.
4. Options:

a. Quantity of Pairs: [**Four**]<**Insert number**>.
b. Shielding/Screening: [**F/FTP**][**S/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

M. UL DUZX and DVBI - Type CMR-LS, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 3.
4. Options:

    a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.
    b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
    c. Jacket:
    [**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

N. UL DUZX and DVBI - Type CMR-LS, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 5e.
4. Options:

    a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
    b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].

c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

O. UL DUZX and DVBI - Type CMR-LS, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LS; Category 6.
4. Options:

   a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
   b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
   c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

P. UL DUZX and DVBI - Type CMR-LSHF, Category 3 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
   b. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   c. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 3.
4. Options:

   a. Quantity of Pairs: [**25**][**50**][**100**]<**Insert number**>.

b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket:
[**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

Q. UL DUZX and DVBI - Type CMR-LSHF, Category 5e Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 5e.
4. Options:

a. Quantity of Pairs: [**25**][**50**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

R. UL DUZX and DVBI - Type CMR-LSHF, Category 6 Communications Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]

b. [**Hitachi Cable America Inc.**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. <**Insert manufacturer's name**>

3. Product Marking: Type CMR-LSHF; Category 6.
4. Options:

a. Quantity of Pairs: [**24**][**Four**]<**Insert number**>.
b. Shielding/Screening: [**UTP**][**FTP**][**F/UTP**][**F/FTP**].
c. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.2 COMMUNICATIONS-, AUDIO/VIDEO-, DATA-, AND OTHER SIGNALING-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for use in residential or commercial communications-station applications for connections to communications circuit as defined in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. <**Insert requirements**>.

2. Listing Criteria:

a. Communications-Circuit Accessories: UL CCN DUXR; including UL 1863.
b. Audio/Video-, Data-, and Other Signaling-Circuit Accessories: UL CCN DUXR; including UL 1977.
c. For Use in Air-Handling Spaces: UL 2043.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

D. UL DUXR - Connecting Block :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Panduit Corp**]

e. [**Siemon Co. (The)**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
c. [**Leviton Manufacturing Co., Inc.**]
d. [**Panduit Corp**]
e. [**Siemon Co. (The)**]
f. <**Insert manufacturer's name**>

3. Options:

a. Configuration: [**110-style IDC for Category 5e**][**110-style IDC for Category 6**][**66-style IDC for Category 5e**].
b. Quantity of Terminations: Number of cables terminated on block, plus [**25**]<**Insert number**> percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. UL DUXR - Cross-Connect :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Panduit Corp**]
d. [**Siemon Co. (The)**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Panduit Corp**]
d. [**Siemon Co. (The)**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

3. Options:

a. Number of Terminals per Field: [**One**]<**Insert number**> for each conductor in assigned cables.
b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

F. UL DUXR - Patch Panel :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. [**Panduit Corp**]
    f. [**Siemon Co. (The)**]
    g. [**TE Connectivity Ltd.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. [**Panduit Corp**]
    f. [**Siemon Co. (The)**]
    g. [**TE Connectivity Ltd.**]
    h. <**Insert manufacturer's name**>

3. General Characteristics:

    a. Universal T568A and T568B wiring labels.
    b. Labeling areas adjacent to conductors.
    c. Replaceable connectors.
    d. 24 or 48 ports.
    e. Construction: 16-gauge steel and mountable on **19 inch (483 mm)** equipment racks.

4. Options:

    a. Number of Jacks per Field: One for each four-pair [**twisted-pair cable indicated**][**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].
    b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

G. UL DUXR - 8P8C Plugs and Plug Assemblies :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

3. General Characteristics:

a. Male; 8P8C; color-coded modular telecommunications connector designed for termination of a single, four-pair, 100 Ω UTP or FTP cable.
b. Marked to indicate transmission performance.

4. Options:

a. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

H. UL DUXR - 8P8C Jacks and Jack Assemblies :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]

c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. [**TE Connectivity Ltd.**]
i. <**Insert manufacturer's name**>

3. General Characteristics:

a. Female; 8P8C; color-coded modular telecommunications connector designed for termination of a single, four-pair, 100 Ω UTP or FTP cable.
b. Designed to snap into patch panel or cover plate.
c. Marked to indicate transmission performance.

4. Options:

a. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

I. UL DUXR - Patch Cords :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
d. [**Leviton Manufacturing Co., Inc.**]
e. [**Molex Premise Networks**]
f. [**Panduit Corp**]
g. [**Siemon Co. (The)**]
h. <**Insert manufacturer's name**>

3. General Characteristics:

a. Factory-made, four-pair cables; terminated with an 8P8C plug at each end.
b. Bend-relief-compliant boots and color-coded icons to ensure Category 6 performance.

c. Latch guards to protect against snagging.
d. Color-coded boots for circuit identification.

4. Options:

a. Length: [3 ft (0.9 m)][4 ft (1.2 m)]<**Insert length**>.
b. Performance Rating: [**Category 5e**][**Category 6**][**Category 6A**][**Category 8**].

J. Accessories:

1. Spare Parts: Furnish to Owner spare parts, for repairing cable assemblies and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

a. Connecting Blocks: [**One**]<**Insert number**> of each type.
b. Patch Panels: [**One**]<**Insert number**> of each type.
c. Plugs: [**Ten**]<**Insert number**> of each type.
d. Jacks: [**Ten**]<**Insert number**> of each type.

2. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to cable assemblies and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

a. <**Insert name of special tool**>.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following:

1. Cable Labeling Schedules: Submit electronic files[**using software and format requested by Owner**].
2. Cabling Administration Diagrams: Submit diagrams and supporting electronic files[**using software and format requested by Owner**].

a. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

3. Wiring Diagrams:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Cross-connects.
f. Patch panels.
g. Patch cords.

4. Cross-Connect and Patch Panel Details: Include mounting assemblies, elevations, and physical relationship between installed components.
5. Twisted-Pair Cable Testing Plan: Include list of cables to be tested, identification of tests to be

performed, pass/fail criteria, and copy of testing procedures (may be separate volume). Indicate Installer's required tests for warranty compliance.

3.2 SELECTION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Air-Handling Spaces:

1. Type CMP[**in listed plenum communications raceway**][**in listed cable routing assembly**].
2. Type CMR or Type CMP[**, Type CM, Type CMG, or Type CMX**] in metallic conduit installed in accordance with Rule 300.22 of NFPA 70.

B. Vertical Chases:

1. Type CMR.
2. Type CMP or Type CMR[**in listed plenum or riser communications raceway**][**in metallic conduit installed in accordance with Rule 300.22 of NFPA 70**].

3.3 INSTALLATION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation:

1. Communications Cable Assemblies: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N1.
2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

   a. Provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
   b. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

2. Drawings indicate general arrangement of pathways and fittings.
3. Wiring Methods:

   a. Raceway and Tray: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables, except in unfinished spaces.

      1) Install plenum cable in environmental air spaces, including plenum ceilings.
      2) Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

   b. Open-Cable: Route conductors and cables in accessible ceilings, walls, and floors where possible.

c. Within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

4. General Requirements for Cabling:

a. Install 110-style IDC termination hardware unless otherwise indicated.
b. Do not untwist twisted-pair cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
c. Terminate all conductors; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
d. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
e. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
f. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars and distribution spools.
g. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
h. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
i. In the communications equipment room, install **10 ft (3 m)** long service loop on each end of cable.
j. Pulling Cable: Monitor cable pull tensions.

5. Open-Cable Installation:

a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
b. Suspend twisted-pair cabling, not in a wireway or pathway, a minimum of **8 inch (200 mm)** above ceilings by cable supports not more than [**5 ft (1.5 m)**]<**Insert dimension**> apart.
c. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

6. Installation of Cable Routed Exposed under Raised Floors:

a. Install plenum-rated cable only.
b. Install cabling after the flooring system has been installed in raised floor areas.
c. Coil cable [**6 ft (1.8 m)**]<**Insert dimension**> long not less than [**12 inch (300 mm)**]<**Insert dimension**> in diameter below each feed point.

7. Group connecting hardware for cables into separate logical fields.
8. Separation from EMI Sources:

a. Comply with BICSI N1 for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
b. Separate open communications cables or cables in nonmetallic raceways from unshielded power conductors and electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum **5 inch (127 mm)**.
2) Power Rating between 2 and 5 kVA: Minimum **12 inch (300 mm)**.
3) Power Rating More Than 5 kVA: Minimum **24 inch (600 mm)**.

c. Separate communications cables in grounded metallic raceways from unshielded power lines or electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum **2-1/2 inch (64 mm)**.
2) Power Rating between 2 and 5 kVA: Minimum **6 inch (150 mm)**.
3) Power Rating More Than 5 kVA: Minimum **12 inch (300 mm)**.

d. Separate communications cables in grounded metallic raceways from power lines and electrical equipment located in grounded metallic conduits or enclosures as follows:

1) Power Rating Less Than 2 kVA: No minimum distance.
2) Power Rating between 2 and 5 kVA: Minimum **3 inch (76 mm)**.
3) Power Rating More Than 5 kVA: Minimum **6 inch (150 mm)**.

e. Separate communications cables from electrical motors and transformers rated 5 kVA or 5 HP and larger minimum **48 inch (1200 mm)**.
f. Separate communications cables from fluorescent luminaires minimum **5 inch (127 mm)**.

9. Identify system components, wiring, and cabling in accordance with TIA-606.

a. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
b. Paint and label colors for equipment identification must comply with TIA-606 for [**Class 2**][**Class 3**][**Class 4**] level of administration[**, including optional identification requirements of this standard**].

10. Cable and Wire Identification:

a. Label each cable within **4 inch (100 mm)** of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
b. Each wire connected to building-mounted devices is not required to be numbered at device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 ft (4.5 m)**.
d. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from panel or cabinet to building-mounted device, with name and number of particular device.
2) Label each unit and field within distribution racks and frames.

e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

11. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.
12. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets,[**backbone pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways,

and equipment grounding conductors.

13. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Entrance Facilities: Coordinate backbone cabling with Section 271100 "Communications Equipment Room Fittings" for cabinets, racks, and protectors and demarcation point provided by communications service provider.
2. Coordinate with Section 078413 "Penetration Firestopping" for sealing fire-rated penetrations.
3. Coordinate with Section 260533.16 "Boxes and Covers for Electrical Systems" for installation of outlet boxes and cover plates.
4. Coordinate with Section 270526 "Grounding and Bonding for Communications Systems" for grounding communications cabling and connectors.
5. Coordinate with Section 270528 "Pathways for Communications Systems" for installation of provisions for routing and terminating cable assemblies.
6. Coordinate with Section 270529 "Hangers and Supports for Communications Systems" for installation of cable supports.
7. Coordinate with Section 270536 "Cable Trays for Communications Systems" for installation of cable trays.
8. Coordinate installation of new products for <**Insert system or product family/category**> with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

9. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

    a. <**Insert requirements for transition between this Section and related Work**>.

3.4 FIELD QUALITY CONTROL OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Visually inspect jacket materials for certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test

equipment manufacturer for channel or link test configuration.

D. Nonconforming Work:

1. Cable assemblies will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective cable assemblies and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 PROTECTION

A. After installation, protect cable assemblies and accessories from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 27 13 13 00

Task	Specification	Specification Description
27 13 13 13	26 05 13 00	Medium-Voltage Cables
27 13 13 13	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
27 13 13 13	27 13 13 00	Communications Copper Backbone Cabling

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SECTION 27 13 23 00 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type OFNR optical fiber cable.
2. Type OFCR optical fiber cable.
3. Type OFNP optical fiber cable.
4. Type OFCP optical fiber cable.
5. Types OFN and OFNG optical fiber cable.
6. Types OFC and OFCG optical fiber cable.
7. Optical fiber cable hardware.

1.2 DEFINITIONS

A. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.

B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

C. Type OFCP: Conductive cable for use in plenums, ducts, and other spaces used for environmental air.

D. Type OFCR: Conductive cable for use as riser in vertical shafts or from floor to floor.

E. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.

F. Type OFNR: Nonconductive cable for use as riser in vertical shafts or from floor to floor.

G. Types OFC and OFCG: Conductive cable for general purpose use.

H. Types OFN and OFNG: Nonconductive cable for general purpose use.

1.3 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Type OFNR optical fiber cable.
2. Type OFCR optical fiber cable.
3. Type OFNP optical fiber cable.

4. Type OFCP optical fiber cable.
5. Types OFN and OFNG optical fiber cable.
6. Types OFC and OFCG optical fiber cable.
7. Optical fiber cable hardware.

B. Shop Drawings:

1. System Labeling Schedules:

   a. Electronic copy of labeling schedules, in software and format selected by Owner.
   b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration drawings and printouts.
3. Wiring diagrams showing typical schematic arrangement, including the following:

   a. Telecommunications rooms plans and elevations.
   b. Telecommunications pathways.
   c. Telecommunications system access points.
   d. Telecommunications grounding system.
   e. Cross-connects.
   f. Patch panels.
   g. Patch cords.

4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates: For each type of product.

D. Field Quality-Control Reports: Optical fiber cable testing plan.

E. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software service agreement.

B. Maintenance Data: For optical fiber cable, splices, and connectors.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Patch-Panel Units: [**One**]<**Insert number**> of each type.
2. Plugs: [**10**]<**Insert number**> of each type.
3. Jacks: [**10**]<**Insert number**> of each type.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine continuity of strand end to end. Use [**optical fiber flashlight**][**or**][**optical loss test set**]<**Insert test instrument**>.
2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.1 TYPE OFNR OPTICAL FIBER CABLE

A. Type OFNR Optical Fiber Cable: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Type OFNR, Designation OM1, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**Berk-Tek, a Leviton Company**]
   c. [**CommScope, Inc**]
   d. [**Corning Optical Communications; Corning Incorporated**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Hitachi Cable America Inc.**]
   g. [**Mohawk; a division of Belden Networking, Inc.**]
   h. [**Prysmian Cables and Systems; Prysmian Group North America**]
   i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**Berk-Tek, a Leviton Company**]
   c. [**CommScope, Inc**]
   d. [**Corning Optical Communications; Corning Incorporated**]
   e. [**General Cable; Prysmian Group North America**]
   f. [**Hitachi Cable America Inc.**]
   g. [**Mohawk; a division of Belden Networking, Inc.**]
   h. [**Prysmian Cables and Systems; Prysmian Group North America**]
   i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492AAAA; 62.5 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Orange**]<**Insert color**>.

D. Type OFNR, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]

b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Corning Optical Communications; Corning Incorporated**]
f. [**General Cable; Prysmian Group North America**]
g. [**Hitachi Cable America Inc.**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Corning Optical Communications; Corning Incorporated**]
f. [**General Cable; Prysmian Group North America**]
g. [**Hitachi Cable America Inc.**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.

E. Type OFNR, Designation OM3, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**Hitachi Cable America Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**Hitachi Cable America Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Aqua**]<**Insert color**>.

F. Type OFNR, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Corning Optical Communications; Corning Incorporated**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. [**TE Connectivity Ltd.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Corning Optical Communications; Corning Incorporated**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. [**TE Connectivity Ltd.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Additional Characteristics:

    a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

5. Options:

    a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
    c. Jacket Color: [**Aqua**]<**Insert color**>.

G. Type OFNR, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Corning Optical Communications; Corning Incorporated**]
    b. [**General Cable; Prysmian Group North America**]
    c. [**Mohawk; a division of Belden Networking, Inc.**]
    d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    e. [**TE Connectivity Ltd.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Corning Optical Communications; Corning Incorporated**]
    b. [**General Cable; Prysmian Group North America**]
    c. [**Mohawk; a division of Belden Networking, Inc.**]
    d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    e. [**TE Connectivity Ltd.**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration:

        1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
        2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

    b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5**

dB/km]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

H. Type OFNR, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**3M**]
b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**3M**]
b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

I. Type OFNR, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

J. Type OFNR, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

2.2 TYPE OFCR OPTICAL FIBER CABLE

A. Type OFCR Optical Fiber Cable: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Type OFCR, Designation OM1, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Mohawk; a division of Belden Networking, Inc.**]
h. [**Prysmian Cables and Systems; Prysmian Group North America**]
i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Mohawk; a division of Belden Networking, Inc.**]
h. [**Prysmian Cables and Systems; Prysmian Group North America**]
i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAA; 62.5 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

D. Type OFCR, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]

e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

E. Type OFCR, Designation OM3, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Corning Optical Communications; Corning Incorporated**]
d. [**Hitachi Cable America Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Corning Optical Communications; Corning Incorporated**]
d. [**Hitachi Cable America Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm wavelength.

5. Options:

    a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
    c. Jacket Color: [**Aqua**]<**Insert color**>.
    d. Armor: [**Steel**][**Aluminum**].

F. Type OFCR, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Corning Optical Communications; Corning Incorporated**]
    d. [**Hitachi Cable America Inc.**]
    e. [**Mohawk; a division of Belden Networking, Inc.**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Corning Optical Communications; Corning Incorporated**]
    d. [**Hitachi Cable America Inc.**]
    e. [**Mohawk; a division of Belden Networking, Inc.**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Aqua**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

G. Type OFCR, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Corning Optical Communications; Corning Incorporated**]
    b. [**General Cable; Prysmian Group North America**]
    c. [**Mohawk; a division of Belden Networking, Inc.**]
    d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Corning Optical Communications; Corning Incorporated**]
    b. [**General Cable; Prysmian Group North America**]
    c. [**Mohawk; a division of Belden Networking, Inc.**]
    d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration:

        1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
        2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

    b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
    c. Jacket Color: [**Yellow**]<**Insert color**>.
    d. Armor: [**Steel**][**Aluminum**].

H. Type OFCR, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

I. Type OFCR, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

J. Type OFCR, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low

water peak.

b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

2.3 TYPE OFNP OPTICAL FIBER CABLE

A. Type OFNP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Type OFNP, Designation OM1, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Mohawk; a division of Belden Networking, Inc.**]
h. [**Prysmian Cables and Systems; Prysmian Group North America**]
i. [**Superior Essex Inc.; subsidiary of LS Corp.**]

j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Mohawk; a division of Belden Networking, Inc.**]
h. [**Prysmian Cables and Systems; Prysmian Group North America**]
i. [**Superior Essex Inc.; subsidiary of LS Corp.**]
j. **<Insert manufacturer's name>**

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAA; 62.5 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.

D. Type OFNP, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]
d. [**CommScope, Inc**]
e. [**Corning Optical Communications; Corning Incorporated**]
f. [**General Cable; Prysmian Group North America**]
g. [**Hitachi Cable America Inc.**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**Berk-Tek, a Leviton Company**]

d. [**CommScope, Inc**]
e. [**Corning Optical Communications; Corning Incorporated**]
f. [**General Cable; Prysmian Group North America**]
g. [**Hitachi Cable America Inc.**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.

E. Type OFNP, Designation OM3, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**Hitachi Cable America Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**Hitachi Cable America Inc.**]
f. [**TE Connectivity Ltd.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm

wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Aqua**]<**Insert color**>.

F. Type OFNP, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Corning Optical Communications; Corning Incorporated**]
   d. [**Hitachi Cable America Inc.**]
   e. [**Mohawk; a division of Belden Networking, Inc.**]
   f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   g. [**TE Connectivity Ltd.**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Belden Inc.**]
   b. [**CommScope, Inc**]
   c. [**Corning Optical Communications; Corning Incorporated**]
   d. [**Hitachi Cable America Inc.**]
   e. [**Mohawk; a division of Belden Networking, Inc.**]
   f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   g. [**TE Connectivity Ltd.**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
   c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

5. Options:

   a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
   b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
   c. Jacket Color: [**Aqua**]<**Insert color**>.

G. Type OFNP, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Corning Optical Communications; Corning Incorporated**]
   b. [**General Cable; Prysmian Group North America**]
   c. [**Mohawk; a division of Belden Networking, Inc.**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. [**TE Connectivity Ltd.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Corning Optical Communications; Corning Incorporated**]
   b. [**General Cable; Prysmian Group North America**]
   c. [**Mohawk; a division of Belden Networking, Inc.**]
   d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   e. [**TE Connectivity Ltd.**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

   a. Configuration:

      1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
      2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

   b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
   c. Jacket Color: [**Yellow**]<**Insert color**>.

H. Type OFNP, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Berk-Tek, a Leviton Company**]
   b. [**CommScope, Inc**]
   c. [**Hitachi Cable America Inc.**]
   d. [**Mohawk; a division of Belden Networking, Inc.**]
   e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Berk-Tek, a Leviton Company**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration:

        1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
        2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

    b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
    c. Jacket Color: [**Yellow**]<**Insert color**>.

I. Type OFNP, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CommScope, Inc**]
    b. [**Corning Optical Communications; Corning Incorporated**]
    c. [**General Cable; Prysmian Group North America**]
    d. [**Hitachi Cable America Inc.**]
    e. [**Mohawk; a division of Belden Networking, Inc.**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**CommScope, Inc**]
    b. [**Corning Optical Communications; Corning Incorporated**]
    c. [**General Cable; Prysmian Group North America**]
    d. [**Hitachi Cable America Inc.**]
    e. [**Mohawk; a division of Belden Networking, Inc.**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]

g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

J. Type OFNP, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Belden Inc.**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

2.4 TYPE OFCP OPTICAL FIBER CABLE

A. Type OFCP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Type OFCP, Designation OM1, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]

d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Mohawk; a division of Belden Networking, Inc.**]
g. [**Prysmian Cables and Systems; Prysmian Group North America**]
h. [**Superior Essex Inc.; subsidiary of LS Corp.**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAA; 62.5 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

D. Type OFCP, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**General Cable; Prysmian Group North America**]
e. [**Hitachi Cable America Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
    c. Jacket Color: [**Orange**]<**Insert color**>.
    d. Armor: [**Steel**][**Aluminum**].

E. Type OFCP, Designation OM3, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm wavelength.

5. Options:

    a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
    c. Jacket Color: [**Aqua**]<**Insert color**>.
    d. Armor: [**Steel**][**Aluminum**].

F. Type OFCP, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]

b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Aqua**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

G. Type OFCP, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**General Cable; Prysmian Group North America**]
b. [**Mohawk; a division of Belden Networking, Inc.**]
c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**General Cable; Prysmian Group North America**]
b. [**Mohawk; a division of Belden Networking, Inc.**]
c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration:

        1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
        2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

    b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
    c. Jacket Color: [**Yellow**]<**Insert color**>.
    d. Armor: [**Steel**][**Aluminum**].

H. Type OFCP, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Berk-Tek, a Leviton Company**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Berk-Tek, a Leviton Company**]
    b. [**CommScope, Inc**]
    c. [**Hitachi Cable America Inc.**]
    d. [**Mohawk; a division of Belden Networking, Inc.**]
    e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

    a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

I. Type OFCP, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

J. Type OFCP, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]

b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

2.5 TYPES OFN AND OFNG OPTICAL FIBER CABLE

A. Types OFN and OFNG Optical Fiber Cable: This category covers jacketed optical fiber cable for general use within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.

d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Types OFN and OFNG, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
b. [**Berk-Tek, a Leviton Company**]
c. [**CommScope, Inc**]
d. [**Corning Optical Communications; Corning Incorporated**]
e. [**General Cable; Prysmian Group North America**]
f. [**Hitachi Cable America Inc.**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.

D. Types OFN and OFNG, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corning Optical Communications; Corning Incorporated**]
b. [**General Cable; Prysmian Group North America**]
c. [**Mohawk; a division of Belden Networking, Inc.**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corning Optical Communications; Corning Incorporated**]
b. [**General Cable; Prysmian Group North America**]
c. [**Mohawk; a division of Belden Networking, Inc.**]
d. [**Superior Essex Inc.; subsidiary of LS Corp.**]
e. [**TE Connectivity Ltd.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

E. Types OFN and OFNG, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Berk-Tek, a Leviton Company**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Berk-Tek, a Leviton Company**]

b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

F. Types OFN and OFNG, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**Corning Optical Communications; Corning Incorporated**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Mohawk; a division of Belden Networking, Inc.**]
f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.

b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.

2.6 TYPES OFC AND OFCG OPTICAL FIBER CABLE

A. Types OFC and OFCG Optical Fiber Cable: This category covers jacketed optical fiber cable for general use within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inch (1 m)**.

C. Types OFC and OFCG, Designation OM2, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Berk-Tek, a Leviton Company**]
b. [**CommScope, Inc**]
c. [**General Cable; Prysmian Group North America**]
d. [**Hitachi Cable America Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Berk-Tek, a Leviton Company**]
b. [**CommScope, Inc**]
c. [**General Cable; Prysmian Group North America**]

d. [**Hitachi Cable America Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492AAAB; 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**4**][**6**][**8**][**12**][**24**][**48**]<**Insert number**>-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: [**3.50 dB/km**]<**Insert dB/km**> at 850 nm wavelength; [**1.5 dB/km**]<**Insert dB/km**> at 1300 nm wavelength.
c. Jacket Color: [**Orange**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

D. Types OFC and OFCG, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**General Cable; Prysmian Group North America**]
b. [**Mohawk; a division of Belden Networking, Inc.**]
c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**General Cable; Prysmian Group North America**]
b. [**Mohawk; a division of Belden Networking, Inc.**]
c. [**Superior Essex Inc.; subsidiary of LS Corp.**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.

c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

E. Types OFC and OFCG, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Berk-Tek, a Leviton Company**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Berk-Tek, a Leviton Company**]
b. [**CommScope, Inc**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration:

1) [**6**][**8**][**12**]-fiber, single loose tube, optical fiber cable.
2) [**24**][**36**][**48**][**72**][**96**][**144**]-fiber, stranded loose tube, optical fiber cable.

b. Maximum Attenuation: [**0.5 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**0.5 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

F. Types OFC and OFCG, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CommScope, Inc**]
b. [**General Cable; Prysmian Group North America**]
c. [**Hitachi Cable America Inc.**]
d. [**Mohawk; a division of Belden Networking, Inc.**]
e. [**Superior Essex Inc.; subsidiary of LS Corp.**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

5. Options:

a. Configuration: [**6**][**8**][**12**][**24**][**36**][**48**][**72**][**96**][**144**] fibers, tight buffered, optical fiber cable.
b. Maximum Attenuation: [**1.0 dB/km**]<**Insert dB/km**> at 1310 nm wavelength; [**1.0 dB/km**]<**Insert dB/km**> at 1550 nm wavelength.
c. Jacket Color: [**Yellow**]<**Insert color**>.
d. Armor: [**Steel**][**Aluminum**].

2.7 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Technology Systems Industries, Inc**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**Dynacom Corporation**]
7. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
8. [**Molex Premise Networks**]
9. [**Optical Cable Corporation (OCC)**]
10. [**Siemon Co. (The)**]
11. [**Stewart Connector, a Bel group company; Bel Fuse Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Technology Systems Industries, Inc**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**Dynacom Corporation**]
7. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
8. [**Molex Premise Networks**]
9. [**Optical Cable Corporation (OCC)**]
10. [**Siemon Co. (The)**]
11. [**Stewart Connector, a Bel group company; Bel Fuse Inc.**]
12. <**Insert manufacturer's name**>

C. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

D. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: [**One**]<**Insert number**> for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Cords: Factory-made, dual-fiber cables in **36 inch (900 mm)** lengths.

F. Connector Type: [**Type SC complying with TIA-604-3,**][**Type ST complying with TIA-604-2,**][**Type LC complying with TIA-604-10,**][**Type MT-RJ complying with TIA-604-12,**][**Type MPO complying with TIA-604-5,**]<**Insert type**> connectors.

G. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than [**0.25**][**0.75**]<**Insert number**> dB.
3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than [**0.25**][**0.75**]<**Insert number**> dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to patch panel or faceplate.

2.8 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: [**Owner will engage**][**Engage**] qualified testing agency to evaluate cables.

C. Factory Tests and Inspections:

1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.
2. Test and inspect pre-terminated optical fiber cable assemblies, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of [**manufacturer's**][**qualified electrical testing laboratory's**] certification of system compliance.

D. Nonconforming Work:

1. Cables that do not pass tests and inspections will be considered defective.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.2 SELECTION OF OPTICAL FIBER TYPE

A. Installed in Vertical Shaft or Floor-to-Floor Riser:

1. Nonconductive:

a. [**Type OFNR**][**or**][**Type OFNP**][**in listed plenum communications raceway**].
b. [**Type OFN**][**Type OFNG**][**Type OFNR**][**or**][**Type OFNP**] in metallic conduit.

2. Conductive:

a. [**Type OFCR**][**or**][**Type OFCP**][**in listed plenum communications raceway**].
b. [**Type OFC**][**Type OFCG**][**Type OFCR**][**or**][**Type OFCP**] in metallic conduit.

B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:

1. Nonconductive:

a. Type OFNP[**in listed plenum communications raceway**].
b. [**Type OFN**][**Type OFNG**][**Type OFNR**][**or**][**Type OFNP**] in metallic conduit.

2. Conductive:

a. Type OFCP[**in listed plenum communications raceway**].
b. [**Type OFC**][**Type OFCG**][**Type OFCR**][**or**][**Type OFCP**] in metallic conduit.

C. Installed in Location Other Than Riser or Plenum:

1. Nonconductive: [**Type OFN**][**Type OFNG**][**Type OFNR**][**or**][**Type OFNP**] in metallic conduit.
2. Conductive: [**Type OFC**][**Type OFCG**][**Type OFCR**][**or**][**Type OFCP**] in metallic conduit.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:

1. Not in Raceway: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
2. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

    a. Install plenum cable in environmental airspaces, including plenum ceilings.
    b. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

3. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inch (760 mm)** and not more than **6 inch (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
9. In communications equipment room, provide **10 ft (3 m)** long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Installation of Cable Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after flooring system has been installed in raised floor areas.
3. Coil cable [**6 ft (1.8 m)**]<**Insert size**> long not less than [**12 inch (300 mm)**]<**Insert size**> in diameter below each feed point.

J. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

A. Install grounding in accordance with BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607 and NECA/BICSI-607.

C. Locate grounding bus bar to minimize length of bonding conductors. Fasten to wall allowing at least **2 inch (50 mm)** clearance behind grounding bus bar. Connect grounding bus bar with minimum 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to grounding bus bar, using not smaller than 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification must comply with TIA-606 for [**Class 2**][**Class 3**][**Class 4**] level of administration[**including optional identification requirements of this standard**].

C. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.

D. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, [**backbone pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

F. Cable and Wire Identification:

1. Label each cable within **4 inch (100 mm)** of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 ft (4.5 m)**.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

G. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.

2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

D. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

E. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.
2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.8 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

   a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 27 13 23 00

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Task	Specification	Specification Description
27 13 23 13	27 13 23 00	Communications Optical Fiber Backbone Cabling

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SECTION 27 15 13 00 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 3 twisted pair cable.
2. Category 5e twisted pair cable.
3. Category 6 twisted pair cable.
4. Category 6a twisted pair cable.
5. Category 7 twisted pair cable.
6. Twisted pair cable hardware.
7. Multiuser telecommunications outlet assembly (MUTOA).
8. Cable management system.
9. Identification products.

B. Related Requirements:

1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately **100 sq. ft. (9.3 sq. m)**, and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is **295 feet (90 m)**. This maximum allowable length does not include an allowance for the length of **16 feet (4.9 m)** to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Category 3 twisted pair cable.
2. Category 5e twisted pair cable.
3. Category 6 twisted pair cable.
4. Category 6a twisted pair cable.
5. Category 7 twisted pair cable.
6. Twisted pair cable hardware.
7. Multiuser telecommunications outlet assembly (MUTOA).
8. Cable management system.
9. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.
b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.

c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Telecommunications conductor drop locations.
f. Typical telecommunications details.
g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

E. Samples: For telecommunications jacks and plugs, [**in specified finish, one for each type and configuration**][**and cover plates for color selection and evaluation of technical features**].

F. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**RCDD,**][**Installer,**]installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**]<**Insert number**> of each type.
2. Cover Plates: [**One**]<**Insert number**> of each type.
3. Jacks: [**Ten**]<**Insert number**> of each type.

4. Multiuser Telecommunications Outlet Assemblies: [**One**]<**Insert number**> of each type.
5. Patch-Panel Units: [**One**]<**Insert number**> of each type.
6. Plugs: [**Ten**]<**Insert number**> of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[**and cabling administration Drawings**][**, cabling administration Drawings, and field testing program development**] by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of [**Technician**][**Level 2 Installer**], who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated:

a. Type CMP complying with UL 1685[**or Type CMP in listed plenum communications raceway**][**or Type CMP in listed cable routing assembly**].
b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2. Communications, Non-Plenum Rated:

a. Type CMR complying with UL 1666[**and ICEA S-103-701**].
b. Type CMP or Type CMR in listed plenum or riser communications raceway.
c. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**]<**Insert value**> or less.
2. Smoke-Developed Index: [**50**][**450**]<**Insert value**> or less.

C. RoHS compliant.

2.3 CATEGORY 3 TWISTED PAIR CABLE

A. Category 3 Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 3 cable at frequencies up to 16 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hitachi Cable America Inc.**]
2. [**Mohawk; a division of Belden Networking, Inc.**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Hitachi Cable America Inc.**]
2. [**Mohawk; a division of Belden Networking, Inc.**]
3. <**Insert manufacturer's name**>

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 3 cables.

E. Conductors: 100-ohm, 24 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**][**Orange**][**Pink**][**Green**][**Red**][**Black**][**Brown**][**Beige**][**Mauve**]<**Insert color**> thermoplastic.

2.4 CATEGORY 5e TWISTED PAIR CABLE

A. Category 5e Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**West Penn Wire; brand of Belden, Inc.**]
9. <**Insert manufacturer's name**>

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

E. Conductors: 100-ohm, 24 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**]<**Insert color**> thermoplastic.

2.5 CATEGORY 6 TWISTED PAIR CABLE

A. Category 6 Twisted Pair Cable: Four-pair, balanced -twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

D. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

E. Conductors: 100-ohm, 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.6 CATEGORY 6a TWISTED PAIR CABLE

A. Category 6a Twisted Pair Cable: Four-pair, balanced twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
3. [**Belden Inc.**]
4. [**Berk-Tek, a Leviton Company**]
5. [**CommScope, Inc**]
6. [**General Cable; Prysmian Group North America**]
7. [**Genesis; Resideo Technologies, Inc.**]
8. [**Hitachi Cable America Inc.**]
9. [**Mohawk; a division of Belden Networking, Inc.**]
10. [**Prysmian Cables and Systems; Prysmian Group North America**]
11. [**Superior Essex Inc.; subsidiary of LS Corp.**]
12. <**Insert manufacturer's name**>

D. Standard: Comply with TIA-568-C.2 for Category 6a cables.

E. Conductors: 100-ohm, 23 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: [**Unshielded twisted pairs (UTP)**][**Shielded twisted pairs (FTP)**][**Screened twisted pairs (F/UTP)**][**Screened and shielded twisted pairs (F/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.7 CATEGORY 7 TWISTED PAIR CABLE

A. Category 7 Twisted Pair Cable: Four-pair, balanced twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 7 cable at frequencies up to 600 MHz.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Hitachi Cable America Inc.**]
2. [**Siemon Co. (The)**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Hitachi Cable America Inc.**]
2. [**Siemon Co. (The)**]
3. <**Insert manufacturer's name**>

D. Standard: Comply with ISO 11801, Category F.

E. Conductors: 100-ohm, 22 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: Overall [**foil shield with foil shielded twisted pairs (F/FTP)**][**braided shield with foil shielded twisted pairs (S/FTP)**].

G. Cable Rating: [**Riser**][**Plenum**].

H. Jacket: [**White**][**Gray**][**Blue**][**Yellow**]<**Insert color**> thermoplastic.

2.8 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]
18. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**American Technology Systems Industries, Inc**]
3. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
4. [**Belden Inc.**]
5. [**Berk-Tek, a Leviton Company**]
6. [**CommScope, Inc**]
7. [**Dynacom Corporation**]
8. [**General Cable; Prysmian Group North America**]
9. [**Genesis; Resideo Technologies, Inc.**]
10. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
11. [**Leviton Manufacturing Co., Inc.**]
12. [**Mohawk; a division of Belden Networking, Inc.**]
13. [**Molex Premise Networks**]
14. [**Panduit Corp**]
15. [**Prysmian Cables and Systems; Prysmian Group North America**]
16. [**Siemon Co. (The)**]
17. [**Superior Essex Inc.; subsidiary of LS Corp.**]
18. <**Insert manufacturer's name**>

D. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of [**Category 5e**][**Category 6**][**Category 6a**][**Category 7**].
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

E. Source Limitations: [**Obtain twisted pair cable hardware from single source from single manufacturer.**][**Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.**]

F. Connecting Blocks:

1. 110-style IDC for Category 5e.
2. 66-style IDC for Category 5e.
3. 110-style IDC for Category 6.
4. 110-style IDC for Category 6a.
5. Provide blocks for the number of cables terminated on the block, plus [**25**]<**Insert number**> percent spare, integral with connector bodies, including plugs and jacks where indicated.

G. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: [**One**]<**Insert number**> for each conductor in assigned cables.

H. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on **19-inch (483 mm)** equipment racks.

3. Number of Jacks per Field: One for each four-pair [**cable indicated**][**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].

I. Patch Cords: Factory-made, four-pair cables in [**36-inch (900-mm)**][**48-inch (1200-mm)**]<**Insert length**> lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

J. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

K. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

L. Cover Plate:

1. [**Two**][**Four**][**Six**] port, vertical single gang cover plates designed to mount to single gang wall boxes.
2. [**Eight**][**Ten**][**Twelve**] port, vertical double gang cover plates designed to mount to double gang wall boxes.
3. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
4. Metal Cover Plate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

M. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.9 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Belden Inc.**]
2. [**Chatsworth Products, Inc.**]
3. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]

4. [**Molex Premise Networks**]
5. [**Ortronics, Inc.**]
6. [**Panduit Corp**]
7. [**Siemon Co. (The)**]
8. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Belden Inc.**]
2. [**Chatsworth Products, Inc.**]
3. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
4. [**Molex Premise Networks**]
5. [**Ortronics, Inc.**]
6. [**Panduit Corp**]
7. [**Siemon Co. (The)**]
8. <**Insert manufacturer's name**>

C. Description: MUTOAs shall meet the requirements of "Twisted Pair Cable Hardware" Article.

1. Number of Terminals per Field: [**One**]<**Insert number**> for each conductor in assigned cables.
2. Number of Connectors per Field:

    a. [**One**]<**Insert number**> for each four-pair unshielded or shielded twisted pair cable indicated.
    b. [**One**]<**Insert number**> for each four-pair unshielded or shielded twisted pair group of indicated cables, plus [**25**]<**Insert number**> percent spare positions.

3. Mounting: [**Recessed in ceiling**][**Wall**][**Desk**][**Furniture**].
4. NRTL listed as complying with UL 50 and UL 1863.
5. Label shall include maximum length of work area cords, based on TIA-568-C.1.
6. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.10 CABLE MANAGEMENT SYSTEM

A. Cable Management System: Computer-based cable management system, with integrated database[**and graphic**] capabilities.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**iTRACS Corporation**]
2. [**Telsoft Solutions**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**iTRACS Corporation**]
2. [**Telsoft Solutions**]
3. <**Insert manufacturer's name**>

D. Document physical characteristics by recording the network, TIA details, and connections between

equipment and cable.

E. Information shall be presented in database view[**, schematic plans, or technical drawings**].

1. [**Microsoft Visio Professional**][**or**][**AutoCAD**] drawing software shall be used as drawing and schematic plans software.

F. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.11 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables, except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 260529 "Hangers and Supports for Electrical Systems."

D. Comply with Section 260536 "Cable Trays for Electrical Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:
    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted pair cables at least **49 feet (15 m)** from communications equipment room.
8. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a **10-foot- (3-m-)** long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than [**60 inches (1524 mm)**]<**Insert dimension**> apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet (1800 mm)**]<**Insert size**> long not less than [**12 inches (300 mm)**]<**Insert size**> in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches (300 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (600 mm)**.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (300 mm)**.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches (76 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for [**Class 2**][**Class 3**][**Class 4**] level of administration[**, including optional identification requirements of this standard**].

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable

or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <**Insert requirements**>.

B. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

C. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

E. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.8 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

    a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 27 15 13 00

Task	Specification	Specification Description
27 15 13 00	26 05 13 00	Medium-Voltage Cables
27 15 13 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
27 15 13 00	26 05 23 00	Control-Voltage Electrical Power Cables

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SECTION 27 15 23 00 - COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 62.5/125-micrometer, multimode, optical fiber cable (OM1).
2. 50/125 micrometer, multimode, optical fiber cable (OM2).
3. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
4. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
5. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS1).
6. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS2).
7. Optical fiber cable hardware.
8. Cross-connects and patch panels.
9. Grounding.
10. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.3 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION

A. Optical fiber horizontal cabling system is to provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling is to contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
3. Bridged taps and splices are not to be installed in the horizontal cabling.

B. A work area is approximately **100 sq. ft. (9.3 sq. m)**, and includes the components that extend from the equipment outlets to the equipment.

C. The maximum allowable horizontal cable length is **295 feet (90 m)**. This maximum allowable length does not include an allowance for the length of **16 feet (4.9 m)** to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:

1. 62.5/125-micrometer, multimode, optical fiber cable (OM1).
2. 50/125 micrometer, multimode, optical fiber cable (OM2).
3. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
4. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
5. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS1).
6. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS2).
7. Optical fiber cable hardware.
8. Cross-connects and patch panels.
9. Grounding.
10. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

   a. Electronic copy of labeling schedules, in software and format selected by Owner.
   b. Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

   a. Telecommunications rooms plans and elevations.
   b. Telecommunications pathways.
   c. Telecommunications system access points.
   d. Telecommunications grounding system.
   e. Telecommunications conductor drop locations.
   f. Typical telecommunications details.
   g. Mechanical, electrical, and plumbing systems.

C. Fiber optic cable testing plan.

D. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.

E. Samples: For telecommunications jacks and plugs, [**in specified finish, one for each type and configuration**][**and faceplates for color selection and evaluation of technical features**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**RCDD,**][**Installer,**]installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

B. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**]<**Insert number**> of each type.
2. Jacks: [**Ten**]<**Insert number**> of each type.
3. Patch-Panel Units: [**One**]<**Insert number**> of each type.
4. Plugs: [**Ten**]<**Insert number**> of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[**and Cabling Administration Drawings**][**, Cabling Administration Drawings, and field testing program development**] by an [**RCDD**][**Technician**].
2. Installation Supervision: Installation is to be under the direct supervision of [**Technician**][**Level 2 Installer**], who is to be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an [**RCDD**][**Technician**].

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use [**optical fiber flashlight**][**or**][**optical loss test set**]<**Insert test instrument**>.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each.

Retain test data and include the record in maintenance data.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications equipment and service suppliers.

1.12 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for [**two**]<**Insert number**> years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software is to include operating system. Upgrade is to include new or revised licenses for use of software.

1. Provide [**30**]<**Insert number**> days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system is to comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 62.5/125-MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM1)

A. Description: Multimode, 62.5/125-micrometer, [**1**][**2**][**4**]<**Insert number**>-fiber, [**nonconductive**][**conductive**], tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Belden Inc.**]

2. [**Berk-Tek, a Leviton Company**]
3. [**CommScope, Inc**]
4. [**Corning Optical Communications; Corning Incorporated**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**Prysmian Cables and Systems; Prysmian Group North America**]
9. [**Superior Essex Inc.; subsidiary of LS Corp.**]
10. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Belden Inc.**]
2. [**Berk-Tek, a Leviton Company**]
3. [**CommScope, Inc**]
4. [**Corning Optical Communications; Corning Incorporated**]
5. [**General Cable; Prysmian Group North America**]
6. [**Hitachi Cable America Inc.**]
7. [**Mohawk; a division of Belden Networking, Inc.**]
8. [**Prysmian Cables and Systems; Prysmian Group North America**]
9. [**Superior Essex Inc.; subsidiary of LS Corp.**]
10. <**Insert manufacturer's name**>

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAA for detailed specifications.

E. Conductive cable is to be [**steel**][**aluminum**] armored type.

F. Maximum Attenuation: [**3.50**]<**Insert number**> dB/km at 850 nm; [**1.5**]<**Insert number**> dB/km at 1300 nm.

G. Minimum Overfilled Modal Bandwidth-length Product: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

H. Jacket:

1. Jacket Color: [**Orange**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color is to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

   a. Type OFNP, complying with NFPA 262.
   b. Type OFNP in listed plenum communications raceway.
   c. Type OFNP or Type OFNR in metallic conduit.
   d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

a. Type OFCP complying with NFPA 262.
b. Type OFCP or Type OFNP in listed plenum communications raceway.
c. Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.3 50/125 MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM2)

A. Description: Multimode, 50/125-micrometer, [**1**][**2**][**4**]<**Insert number**>-fiber, [**nonconductive**][**conductive**], tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**General Cable; Prysmian Group North America**]
7. [**Hitachi Cable America Inc.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**General Cable; Prysmian Group North America**]
7. [**Hitachi Cable America Inc.**]
8. [**Superior Essex Inc.; subsidiary of LS Corp.**]
9. <**Insert manufacturer's name**>

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAB for detailed specifications.

E. Conductive cable is to be [**steel**][**aluminum**] armored type.

F. Maximum Attenuation: [**3.50**]<**Insert number**> dB/km at 850 nm; [**1.5**]<**Insert number**> dB/km at 1300 nm.

G. Minimum Overfilled Modal Bandwidth-length Product: 500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

H. Jacket:

1. Jacket Color: [**Orange**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.
c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

a. Type OFCP[**or Type OFNP**], complying with NFPA 262.
b. Type OFCP or Type OFNP in listed plenum communications raceway.
c. Type OFC, Type OFN, Type OFCG, Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.4 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

A. Description: Multimode, 50/125-micrometer, [**1**][**2**][**4**]<**Insert number**>-fiber, [**nonconductive**][**conductive**], tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Corning Optical Communications; Corning Incorporated**]
5. [**Hitachi Cable America Inc.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AMP NETCONNECT; a TE Connectivity Ltd. company**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Corning Optical Communications; Corning Incorporated**]
5. [**Hitachi Cable America Inc.**]
6. [**TE Connectivity Ltd.**]
7. <**Insert manufacturer's name**>

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.

3. Comply with TIA-492AAAC for detailed specifications.

E. Conductive cable is to be [**steel**][**aluminum**] armored type.

F. Maximum Attenuation: [**3.50**]<**Insert number**> dB/km at 850 nm; [**1.5**]<**Insert number**> dB/km at 1300 nm.

G. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

H. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.

I. Jacket:

1. Jacket Color: [**Aqua**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

J. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.
c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

a. Type OFCP[**or Type OFNP**], complying with NFPA 262.
b. Type OFCP or Type OFNP in listed plenum communications raceway.
c. Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.5 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM4)

A. Description: Multimode, 50/125-micrometer, [**1**][**2**][**4**]<**Insert number**>-fiber, [**nonconductive**][**conductive,**]tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Belden Inc.**]
2. [**CommScope, Inc**]
3. [**Corning Optical Communications; Corning Incorporated**]
4. [**Hitachi Cable America Inc.**]
5. [**Mohawk; a division of Belden Networking, Inc.**]

6. [**Superior Essex Inc.; subsidiary of LS Corp.**]
7. [**TE Connectivity Ltd.**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Belden Inc.**]
2. [**CommScope, Inc**]
3. [**Corning Optical Communications; Corning Incorporated**]
4. [**Hitachi Cable America Inc.**]
5. [**Mohawk; a division of Belden Networking, Inc.**]
6. [**Superior Essex Inc.; subsidiary of LS Corp.**]
7. [**TE Connectivity Ltd.**]
8. <**Insert manufacturer's name**>

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAD for detailed specifications.

E. Conductive cable is to be [**steel**][**aluminum**] armored type.

F. Maximum Attenuation: [**3.50**]<**Insert number**> dB/km at 850 nm; [**1.5**]<**Insert number**> dB/km at 1300 nm.

G. Minimum Overfilled Modal Bandwidth-length Product: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

H. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.

I. Jacket:

1. Jacket Color: [**Aqua**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

J. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

   a. Type OFNP, complying with NFPA 262.
   b. Type OFNP in listed plenum communications raceway.
   c. Type OFNP or Type OFNR in metallic conduit.
   d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

   a. Type OFCP, complying with NFPA 262.
   b. Type OFCP or Type OFNP in listed plenum communications raceway.
   c. Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.6 9/125 MICROMETER SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS1)

A. Description: Single mode, 9/125-micrometer, [**1**][**2**]<**Insert number**> fibers, tight buffered, [**nonconductive**][**conductive**] optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**Belden Inc.**]
3. [**Corning Optical Communications; Corning Incorporated**]
4. [**General Cable; Prysmian Group North America**]
5. [**Mohawk; a division of Belden Networking, Inc.**]
6. [**Superior Essex Inc.; subsidiary of LS Corp.**]
7. [**TE Connectivity Ltd.**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**Belden Inc.**]
3. [**Corning Optical Communications; Corning Incorporated**]
4. [**General Cable; Prysmian Group North America**]
5. [**Mohawk; a division of Belden Networking, Inc.**]
6. [**Superior Essex Inc.; subsidiary of LS Corp.**]
7. [**TE Connectivity Ltd.**]
8. <**Insert manufacturer's name**>

D. Conductive cable is to be [**steel**][**aluminum**] armored type.

E. Maximum Attenuation: [**0.5**]<**Insert number**> dB/km at 1310 nm; [**0.5**]<**Insert number**> dB/km at 1550 nm.

F. Jacket:

1. Jacket Color: [**Yellow**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

G. Standards:

1. Comply with TIA-492CAAA for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.

c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

a. Type OFCP, complying with NFPA 262.
b. Type OFCP or Type OFNP in listed plenum communications raceway.
c. Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.7 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, [**1**][**2**]<**Insert number**> fibers, tight buffered, [**nonconductive**][**conductive**] optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**3M**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Hitachi Cable America Inc.**]
6. [**Mohawk; a division of Belden Networking, Inc.**]
7. [**Superior Essex Inc.; subsidiary of LS Corp.**]
8. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**3M**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Hitachi Cable America Inc.**]
6. [**Mohawk; a division of Belden Networking, Inc.**]
7. [**Superior Essex Inc.; subsidiary of LS Corp.**]
8. <**Insert manufacturer's name**>

D. Conductive cable is to be [**steel**][**aluminum**] armored type.

E. Maximum Attenuation: [**0.5**]<**Insert number**> dB/km at 1310 nm; [**0.5**]<**Insert number**> dB/km at 1550 nm.

F. Jacket:

1. Jacket Color: [**Yellow**]<**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

G. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

   a. Type OFNP, complying with NFPA 262.
   b. Type OFNP in listed plenum communications raceway.
   c. Type OFNP or Type OFNR in metallic conduit.
   d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2. Plenum Rated, Conductive:

   a. Type OFCP, complying with NFPA 262.
   b. Type OFCP or Type OFNP in listed plenum communications raceway.
   c. Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.8 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Technology Systems Industries, Inc**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**Dynacom Corporation**]
7. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
8. [**Molex Premise Networks**]
9. [**Optical Cable Corporation (OCC)**]
10. [**Siemon Co. (The)**]
11. [**Stewart Connector, a Bel group company; Bel Fuse Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Technology Systems Industries, Inc**]
2. [**Belden Inc.**]
3. [**Berk-Tek, a Leviton Company**]
4. [**CommScope, Inc**]
5. [**Corning Optical Communications; Corning Incorporated**]
6. [**Dynacom Corporation**]
7. [**Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated**]
8. [**Molex Premise Networks**]
9. [**Optical Cable Corporation (OCC)**]
10. [**Siemon Co. (The)**]

11. [**Stewart Connector, a Bel group company; Bel Fuse Inc.**]
12. <**Insert manufacturer's name**>

C. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

D. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: [**One**]<**Insert number**> for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Cords: Factory-made, single-fiber cables in **36-inch (900-mm)** lengths.

F. Connector Type: [**Type SC complying with TIA-604-3-B,**][**Type ST complying with TIA-604-2-B,**][**Type LC complying with TIA-604-10-B,**][**Type MT-RJ complying with TIA-604-12,**][**Type MPO complying with TIA-604-5-D,**]<**Insert type**> connectors.

G. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than [**0.25**][**0.75**]<**Insert number**> dB.
3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than [**0.25**][**0.75**]<**Insert number**> dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

I. Faceplate:

1. [**Two**][**Four**][**Six**] -port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. [**Eight**][**Ten**][**Twelve**] -port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
4. Metal Faceplate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 262726 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

2.9 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

C. Factory test preterminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method, Raceways: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method, Concealed: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301 and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable is to contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps are not to be used for heating.
9. In the communications equipment room, provide a **10-foot- (3-m-)** long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable is not to be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet (1800 mm)**]<**Insert size**> long not less than [**12 inches (300 mm)**]<**Insert size**> in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.4 INSTALLATION OF GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment

grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification are to comply with TIA-606-B for [**Class 2**][**Class 3**][**Class 4**] level of administration[**including optional identification requirements of this standard**].

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, [**horizontal pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels are to be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments are to meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for horizontal links are to be less than 2.0 dB. Attenuation test results are to be less than those calculated according to equation in TIA-568-C.1.

E. Data for each measurement are to be documented. Data for submittals are to be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

F. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 27 15 23 00

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SECTION 27 15 33 00 - COMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications coaxial cable.
2. CATV coaxial cable.
3. Coaxial cable hardware.
4. Grounding.
5. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. LAN: Local area network.

E. RCDD: Registered Communications Distribution Designer.

1.3 COAXIAL HORIZONTAL CABLING DESCRIPTION

A. Coaxial horizontal cabling system is to provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Communications coaxial cable.
2. CATV coaxial cable.
3. Coaxial cable hardware.
4. Grounding.
5. Identification products.

B. Product Data Submittals: For each product.

1. Nominal OD.
2. Minimum bending radius.
3. Maximum pulling tension.

C. Shop Drawings:

1. System Labeling Schedule:

a. Electronic copy of labeling schedules, in software and format selected by Owner.
b. Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

2. Cabling administration drawings and printouts.

D. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.
9. Samples: For telecommunications jacks and plugs, [**in specified finish, one for each type and configuration**][**and faceplates for color selection and evaluation of technical features**].

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**RCDD,**][**Installer,**]installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For coaxial cable, splices, and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**]<**Insert number**> of each type.
2. Jacks: [**Ten**]<**Insert number**> of each type.
3. Patch-Panel Units: [**One**]<**Insert number**> of each type.
4. Plugs: [**Ten**]<**Insert number**> of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[**and Cabling Administration Drawings**][**, Cabling Administration Drawings, and field testing program development**] by an [**RCDD**][**Technician**].
2. Installation Supervision: Installation is to be under the direct supervision of [**Technician**][**Level 2 Installer**], who is to be present at all times when Work of this Section is performed at Project site.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each coaxial cable [**on the reel**] for continuity.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system is to comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Communications Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated, Type CMP: Complying with UL 1685[**or Type CMP in listed plenum communications raceway**][**or Type CMP in listed cable routing assembly**].
2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed in accordance with NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. CATV Plenum Rated: Type CATVP [**installed in riser raceways or cable routing assemblies**], complying with NFPA 262.
2. CATV Cable: Type CATV[**, or CATVP or CATVR**][**installed in general purpose, riser, or plenum communications raceways or cable routing assemblies**] in fireproof riser shafts with firestops at each penetration.

2.3 COMMUNICATIONS COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for broadband data transmission.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 13, and with NFPA 70, "Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits" and "Communications Circuits" articles. Types are as follows:

1. RG-6/U: UL Type [**CMP**][**and**][**CL2P**].

    a. No. [**16**][**18**]<**Insert size**> AWG, solid, copper-covered steel conductor.
    b. Plenum rated.
    c. Gas-injected, foam-PE insulation.
    d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
    e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
    f. Jacketed with [**black**][**white**] PVC or PE.
    g. Suitable for indoor installations.

2. RG-11/U: UL Type [**CMP**][**and**][**CL2P**].

    a. No. [**14**]<**Insert size**> AWG, solid, copper-covered steel conductor.
    b. Plenum rated. Suitable for outdoor installations in ambient temperatures ranging from

minus 40 to plus 85 deg F (minus 40 to plus 30 deg C).

c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with sunlight-resistant, [**black**][**white**] PVC or PE.

3. RG-59/U: UL Type [**CMP**][**and**][**CL2P**].

a. No. [**20**]<**Insert size**> AWG, solid copper conductor.
b. Plenum rated.
c. Gas-injected, foam-PE insulation.
d. Single shielded with 100 percent aluminum shield and 40 percent aluminum braid.
e. PVC jacket.

2.4 CATV COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alpha Wire; brand of Belden, Inc.**]
2. [**Belden Inc.**]
3. [**CommScope, Inc**]
4. [**Prysmian Cables and Systems; Prysmian Group North America**]
5. [**Southwire Company, LLC**]
6. <**Insert manufacturer's name**>

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article. Types are as follows:

1. RG-6/U: UL Type CATVP.

a. No. 18 AWG, solid, copper-covered steel conductor.
b. Plenum rated.
c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and [**40**][**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with [**black**][**white**] PVC or PE.
g. Suitable for indoor installations.

2.5 COAXIAL CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Liebert; Vertiv Holdings Co.**]
3. [**Siemon Co. (The)**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Leviton Manufacturing Co., Inc.**]
2. [**Liebert; Vertiv Holdings Co.**]
3. [**Siemon Co. (The)**]
4. <**Insert manufacturer's name**>

D. Coaxial-Cable Connectors: Type BNC, 75 ohms.

E. Jacks and Jack Assemblies: Modular, color-coded, with female Type BNC connectors.

F. Patch Cords: Factory-made cables in [**36-inch (900-mm)**][**48-inch (1200-mm)**]<**Insert length**>lengths; terminated with a male Type BNC connector at each end.

G. Faceplates:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: [**Stainless steel**][**Brass**]<**Insert description**>, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.
    a. Flush-mounted jacks, positioning the cord at a 90-degree angle from faceplate surface.
4. Legend:
    a. Factory labeled by silk-screening or engraving [**for**][**stainless steel**][**brass**]<**Insert description**>[**faceplates**].
    b. Machine printed, in the field, using adhesive-tape label.
    c. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate horizontal cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method, Raceways: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method, Concealed: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Comply with Section 271100 "Communications Equipment Room Fittings." Comply with requirements in Section 270528 "Pathways for Communications Systems" for installation of conduits and wireways.

B. Comply with Section 270528.29 "Hangers and Supports for Communications Systems."

C. Drawings indicate general arrangement of pathways and fittings.

D. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits [**3 inches (76 mm)**]<**Insert dimension**> above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with **96-inch (2440-mm)** dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF COAXIAL HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
2. Terminate all conductors; no cable is to contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps are not to be used for heating.
8. In the communications equipment room, install a **10-foot- (3-m-)** long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend coaxial cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than [**60 inches (1524 mm)**]<**Insert dimension**> apart.
3. Cable is not to be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet (1800 mm)**]<**Insert size**> long not less than [**12 inches (300 mm)**]<**Insert size**> in diameter below each feed point.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding **36 inches (915 mm)**.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **12 inches (300 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (610 mm)**.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (300 mm)**.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures is to be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of **3 inches (76 mm)**.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 INSTALLATION OF GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260529 "Hangers and Supports for Electrical Systems."

1. Administration Class: [**Class 1**][**Class 2**][**Class 3**][**Class 4**].
2. Color-code fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, [**horizontal pathways and cables,**][**entrance pathways and cables,**] terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communications cabling, use a different color for jacks and plugs of each service.

E. Labels are to be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Visually inspect coaxial jacket materials for NRTL certification markings.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test coaxial horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.

E. Data for each measurement are to be documented. Data for submittals are to be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 27 15 33 00

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Task	Specification	Specification Description
27 15 33 00	26 05 13 00	Medium-Voltage Cables
27 15 33 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
27 15 33 00	26 05 23 00	Control-Voltage Electrical Power Cables
27 15 53 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 16 16 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 16 19 00	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
27 16 19 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 21 16 00	27 13 23 00	Communications Optical Fiber Backbone Cabling
27 32 13 00	26 27 26 00	Wiring Devices

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SECTION 27 41 23 00 - EDUCATIONAL INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes microprocessor-switched intercommunications microprocessor-switched, IP-based telephone/intercommunications and program systems with the following components:

1. Administrative console for microprocessor-switched systems.
2. Call control console.
3. Staff and classroom telephone stations.
4. Speaker-microphone stations.
5. Call-switch unit.
6. All-call amplifier.
7. Intercommunication amplifier.
8. Paging amplifier.
9. Cone-type loudspeakers/speaker microphones.
10. Horn-type loudspeakers/speaker microphones.
11. Local Area Network: [**Expansion of existing system**][**Dedicated new system**].

B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
2. Section 271513 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.2 DEFINITIONS

A. DHCP: Dynamic Host Configuration Protocol.

B. FXO: Foreign eXchange Office.

C. H.323: Audio and Video Protocol.

D. SIP: Session Initiation Protocol.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Administrative console for microprocessor-switched systems.
2. Call control console.
3. Staff and classroom telephone stations.
4. Speaker-microphone stations.
5. Call-switch unit.
6. All-call amplifier.
7. Intercommunication amplifier.
8. Paging amplifier.

9. Cone-type loudspeakers/speaker microphones.
10. Horn-type loudspeakers/speaker microphones.
11. Local Area Network: [**Expansion of existing system**][**Dedicated new system**].

B. Shop Drawings: For educational intercommunications and program systems.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include scaled drawings for [**administrative console**][**and**][**speaker-microphone station**] station arrangement of built-in equipment.
4. Include diagrams for power, signal, and control wiring.

a. Identify terminals to facilitate installation, operation, and maintenance.
b. Single-line diagram showing interconnection of components.
c. Cabling diagram showing cable routing.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including luminaires, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
2. Elevation drawings, drawn to scale, on which wall-mounted items including luminaires, intercommunications components, windows, doors, access panels, wall finishes, trims, piping, and conduit are shown and coordinated with each other, using input from Installers of the items involved.

B. Qualification Data: For [**Installer**][**and**][**testing agency**].

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For educational intercommunications and program systems to include in operation and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. A record of final matching transformer-tap settings and signal ground-resistance measurement certified by Installer.
2. A record of Owner's equipment-programming option decisions.
3. Plans, drawn to scale, indicating location, designation, and connection of intercommunications system components.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.

1. Testing Agency's Field Supervisor:

a. Certified by NICET as Audio Systems [**Level II**][**Level III**] Technician.
b. <**Insert qualification**>.

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted speaker microphones and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 EDUCATIONAL INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bogen Communications, Inc**]
2. [**Code Blue Corporation**]
3. [**Jeron Electronic Systems, Inc**]
4. [**Rauland-Borg Corporation**]
5. [**Valcom, Inc.**]
6. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bogen Communications, Inc**]
2. [**Code Blue Corporation**]
3. [**Jeron Electronic Systems, Inc**]
4. [**Rauland-Borg Corporation**]
5. [**Valcom, Inc.**]
6. <**Insert manufacturer's name**>

2.2 SYSTEM DESCRIPTION

A. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz in a satisfactory manner without the requirement of any external power conditioning equipment. Comply with UL 813.

B. Expansion Capability: Increase number of stations in the future by [**25**]<**Insert number**> percent above

those indicated without adding any internal or external components or main trunk cable conductors.

C. Integration: Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.

D. Local Area Network: The system will utilize a LAN for the connectivity of all devices and components within the facility for the transmission of electronic data. The LAN will be an expansion to the existing or a separate standalone structure in support of the intercommunication system as dictated by the project design documents.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for location and application.

F. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

2.3 FUNCTIONAL DESCRIPTION OF MICROPROCESSOR-SWITCHED SYSTEMS

A. Administrative Console:

1. Communicating selectively with other administrative and speaker-microphone stations by dialing station's number on a 12-digit keypad.
2. Communicating with individual stations in privacy.
3. Communicating on a minimum of three voice channels with up to two simultaneous conversations between administrative consoles and one conversation between an administrative console and a speaker-microphone station.
4. Increasing the number of conversation channels by adding a module in central-control cabinet.
5. Include up to three other station connections in a conference call.
6. Access separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
7. Display indicates selected station, originating station call, all-call, zone page, normal or emergency status of call(s), and time/date.
8. Communicating simultaneously with all other stations by dialing a designated number on a 12-digit keypad.
9. Automatic control of gain to ensure constant intercom speech level.
10. Controlling simultaneous distribution of program material to various combinations of speaker-microphone stations or groups over two program channels by using keypad to control sources and distribute programs.
11. Operating and controlling class-change signals to speakers and bells by using keypad.
12. User-programmable features include the following:

    a. Station calling by room number.
    b. Room station call-in priority levels.
    c. Audible signal schedule functions.
    d. Schedule characteristics of audible signals.
    e. Call-in tone characteristic.
    f. Grouping of rooms and speakers into zones for paging and program distribution purposes.

B. Speaker-Microphone Station:

1. Remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
2. Communicating hands free.
3. Calling administrative console by actuating call switch.

4. Returning a busy signal to indicate that station is already in use.

C. Speakers: Free of noise and distortion during operation and when in standby mode.

2.4 FUNCTIONAL DESCRIPTION OF IP-BASED TELEPHONE/INTERCOMMUNICATION SYSTEMS

A. Integrated central system with the following:

1. Direct-dial, full duplex private telephone communications between all locations equipped with telephones [**and IP-addressable speaker-microphone**]. Call initiation among administrative consoles and between administrative consoles and remote stations by dialing station's number on a 12-digit keypad.
2. [**16**]<**Insert number**> channels for unrestricted simultaneous communications.
3. Initial system operation with <**Insert number**> administrative console and remote stations, expandable to 720 stations.
4. Direct-dial, two-way amplified voice intercommunication between administrative console telephones and remote stations without use of press-to-talk or talk-listen switches.
5. Automatic queuing for intercommunication channels, with automatic call waiting.
6. Call transfer among administrative consoles.
7. Display of selected station and answering calling station by pressing a single "response button."
8. Simultaneous communication with other stations on system by dialing a designated number on a 12-digit keypad.
9. Automatic gain control to ensure constant intercom speech level.
10. Simultaneous distribution of emergency announcements to all locations equipped with speakers by dialing a predetermined code number.
11. User-selectable facility for providing selected telephone stations with dial tone for external telephone calls.
12. Assignment of speaker locations within any one or more of eight zones for zone paging or time signal reception.
13. Digital readout displays on which up to three incoming calls are displayed with additional calls stored for subsequent display.
14. Off-site diagnostics to monitor system functions, operations, and faults through a serial data port on central-control station.
15. Control of simultaneous distribution of program material to various combinations of remote stations or groups by using keypad to control sources and distribute programs.
16. User-programmable features include the following:

    a. Station calling by room number.
    b. Room station call-in priority levels.
    c. Audible signal schedule functions.
    d. Schedule characteristics of audible signals.
    e. Call-in tone characteristic.
    f. Precedence among administrative consoles as destinations for incoming calls from room stations.
    g. Grouping rooms and speakers into zones for paging and program distribution purposes.

17. Telephone interconnect shall be capable of accepting H.323, SIP, and FXO type protocols and include the following features:

    a. Direct connection to central office trunk lines with initial system wiring for <**Insert number**> trunk lines.
    b. Routing of outside trunk lines for "attendant answer incoming" and "direct inward line" functions.
    c. Station programming for access to outside trunk lines to be any of the following:

1) Totally unrestricted access.
2) Restricted access.
3) No access.

d. System programming to allow or disallow local prefixes, and to authorize access for as many as three area codes.
e. Discriminating ringing for identifying internal and outside calls.
f. Circular hunting for outside trunks to prevent excess usage of any one trunk.
g. Direct connection of a single trunk to designated telephone with transfer to attendant if unanswered.
h. Call parking allowing paged party to remotely pick up outside call from any station.
i. Night-answer mode to allow one or all of the following:

1) Incoming call transferred to predetermined extension.
2) Tone transmitted to speakers to notify key personnel to answer telephone.
3) Dial tone to remote stations to allow answering call from all locations.

j. Call control console to perform as follows:

1) Identify, answer, and route incoming outside calls, with reminder and recall features.
2) Directly access outside trunk lines.
3) Hold, park, and transfer calls.
4) Screen outside calls.

B. Remote Stations:

1. Staff and Classroom Telephone Station:

a. Corded handset or hands-free speakerphone operation.
b. Capable of placing outside call.
c. Ability to transfer calls.
d. Call forwarding functions.
e. Paging and emergency call placement.
f. Speed-dial programming.
g. Programmable restrictive functions.

2. Speaker-Microphone Station:

a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
b. Communicating hands free.
c. Calling administrative console by actuating call switch.
d. Returning a busy signal to indicate that station is already in use.

C. Speakers: Free of noise and distortion during operation and when in standby mode.

2.5 ADMINISTRATIVE CONSOLE FOR MICROPROCESSOR-SWITCHED SYSTEMS

A. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.

B. Volume Control: Regulates incoming-call volume.

C. Tone Annunciation: Momentary audible tone signal announces incoming calls.

D. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.

E. Speaker Microphone: Transmits intercom voice signals when used via a voice-operated switch.

1. Minimum Speaker Sensitivity: 91 dB at one meter, with 1-W input.

F. Hard Buttons: To transfer and place calls on hold.

G. Reset Control: Cancels call and resets system for next call.

H. Digital Display: 16-digit alphanumeric LCD readout to register up to four three-digit station numbers.

I. Central-Equipment Cabinet: Comply with EIA/ECA-310-E. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.

2.6 CALL CONTROL CONSOLE

A. Microprocessor-based instrument to process outside and internal calls with a 12-digit keypad selector.

B. 20-character alphanumeric display for the following:

1. Simultaneous display of up to three calling stations plus last station dialed.
2. Display of calls in order received with emergency calls taking precedence on the display.
3. Review of calls stored in groups of four.
4. Display of prompt messages to assist in system operation.

C. Programmable Keys: Minimum of 20 with LED indicators for ringing/busy status; programmable for trunk and operator functions.

D. Transfer Button: Calls to busy extensions and unanswered calls automatically returned to call control console.

E. Hold Button: With reminder feature every 30 seconds for parked calls or calls placed on hold.

F. Release Button: For use with parked calls or calls placed on hold.

G. Page Button: For engaging system paging functions.

H. Programmable for night answer, remote answer, and remote pickup features.

I. Programmable for distribution of emergency announcements, all-page announcements, zone-page announcements, and emergency/evacuation alert.

J. Central-Control Cabinet Equipment: Central switching equipment, central office adapter module, line link modules, power supplies, chassis adapters, and other switching and control devices required for trunk and internal conversation channels and control functions.

2.7 STAFF AND CLASSROOM TELEPHONE STATIONS

A. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.

B. Enclosure: Galvanized steel with **2-1/2-inch (64-mm)** minimum depth.

C. 12-Digit Keypad: Input device to initiate calls and commands.

D. Volume Control: Regulates incoming-call volume.

E. Tone Annunciation: Momentary audible tone signal announces incoming calls.

F. LED Annunciation: Identifies calling stations and stations in use. Lamp remains on until call is answered.

G. Speaker Microphone: Transmits intercom voice signals when used via a voice-operated switch.

1. Minimum Speaker Sensitivity: 91 dB at one meter, with 1-W input.

H. Handset with Hook Switch: Telephone type with **18-inch- (450-mm-)** long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

2.8 SPEAKER-MICROPHONE STATIONS

A. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.

B. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.

C. Enclosure: Two-gang galvanized steel with **2-1/2-inch (64-mm)** minimum depth.

D. Speaker: Minimum axial sensitivity shall be 91 dB at one meter, with 1-W input. Voice coil shall be not less than **3 inches (76 mm)**, **2.3 oz. (65 g)** minimum; permanent magnet.

E. Tone Annunciation: Recurring momentary tone indicates incoming calls.

F. Call Switch: Mount on faceplate. Permits calls to administrative console.

G. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.

2.9 CALL-SWITCH UNIT

A. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.

B. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.

C. Enclosure: Single-gang box with stainless-steel faceplate.

D. Call Switch: Momentary contact signals system that a call has been placed.

E. Privacy Switch: Prevents transmission of sound signals from station to system.

F. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.

2.10 ALL-CALL AMPLIFIER

A. Output Power: 70-V balanced line. [**80 percent of the sum of wattage settings of connected**]<**Insert wattage**> for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.

B. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.

C. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

D. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.

E. Output Regulation: Maintains output level within 2 dB from full to no load.

F. Input Sensitivity: Compatible with administrative console and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on administrative console, speaker microphones, or handset transmitters.

G. Amplifier Protection: Prevents damage from shorted or open output.

2.11 INTERCOMMUNICATION AMPLIFIER

A. Minimum Output Power: 15 W; adequate for all functions.

B. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.

C. Minimum Signal-to-Noise Ratio: 50 dB, at rated output.

D. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.

E. Output Regulation: Maintains output level within 2 dB from full to no load.

F. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on microphones in administrative console, speaker microphones, or handset transmitters.

G. Amplifier Protection: Prevents damage from shorted or open output.

2.12 PAGING AMPLIFIER

A. Input Voltage: 120-V ac, 60 Hz.

B. Frequency Response: Within plus or minus 3 dB from 60 to 10,000 Hz.

C. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

D. Total Harmonic Distortion: Less than 3 percent at rated output power from 70 to 12,000 Hz.

E. Output Regulation: Less than 2 dB from full to no load.

F. Controls: On-off, input levels, and low-cut filter.

G. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphones or handset transmitters.

H. Amplifier Protection: Prevents damage from shorted or open output.

2.13 CONE-TYPE LOUDSPEAKERS/SPEAKER MICROPHONES

A. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.

B. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.

C. Minimum Dispersion Angle: 100 degrees.

D. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

E. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least **0.0478-inch (1.2-mm)** steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.

F. Baffle: For flush speakers, minimum thickness of **0.032-inch (0.8-mm)** aluminum [**brushed to a satin sheen and lacquered**][**with textured white finish**]<**Insert finish**>.

G. Vandal-Proof, High-Strength Baffle: For [**flush**][**surface**]-mounted speakers, self-aging cast aluminum with tensile strength of **44,000 psi (303 MN/sq. m)**, **0.025-inch (0.65-mm)** minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.

H. Size: **8 inches (200 mm)** with **1-inch (25-mm)** voice coil and minimum **5-oz. (140-g)** ceramic magnet.

2.14 HORN-TYPE LOUDSPEAKERS/SPEAKER MICROPHONES

A. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.

B. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.

C. Minimum Power Rating of Driver: 15 W, continuous.

D. Minimum Dispersion Angle: 110 degrees.

E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

2.15 IP ADDRESSABLE MODULES

A. Modules utilized for the operation of the intercommunication and paging functions.

1. POE 802.3af compliant.
2. Support DHCP.
3. RJ45 connectivity.

B. Speaker Modules:

1. Interface with speaker and multiple call switches.
2. Capable of providing privacy function for speaker/microphone when activated.
3. Rated for installation within air plenum spaces.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method, Raceways: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method, Concealed: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
2. Suspend cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceiling by cable supports not more than [**60 inches (1524 mm)**]<**Insert dimension**> apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least **12 inches (300 mm)** apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.3 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Mounting of Stations: Surface mount at **54 inches (137.2 cm)** above finished floor to center of station unless otherwise indicated.

3.4 INSTALLATION OF GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 SYSTEM PROGRAMMING

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**]:

D. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing educational intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Test originating station-to-station**[, all-call, and page**] messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
4. Frequency Response Test: Determine frequency response of two transmission paths**[, including all-call and paging,**] by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at[**paging**] speakers.
    b. Repeat test for three speaker microphones, [**and**]one administrative console microphone**[, and for each separately controlled zone of paging loudspeakers**].
    c. Minimum acceptable ratio is 45 dB.

6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each intercom**[, paging, and all-call amplifier**]. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
7. [**Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.**]
8. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
9. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.

F. Educational intercommunications and program systems will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service and initial system programming.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the educational intercommunications and program systems.

1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining the system and equipment.

END OF SECTION 27 41 23 00

Task	Specification	Specification Description
27 41 23 00	26 33 43 00a	Public Address Systems

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SECTION 27 41 33 00 - MASTER ANTENNA TELEVISION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. MATV equipment.
2. Off-air antennas.
3. MATV headend components.
4. Distribution components.

B. Related Sections:

1. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
2. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
3. Section 271333 "Communications Coaxial Backbone Cabling" for riser-rated coaxial data cabling associated with system panels and devices.
4. Section 271513 "Communications Copper Horizontal Cabling" for balanced twisted-pair optical-fiber cables and connectors.
5. Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical-fiber cables and connectors.
6. Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial cables and connectors.
7. Section 282000 "Video Surveillance" for cameras, monitors, computers, and cabling for video surveillance systems.

1.2 DEFINITIONS

A. Agile Receiver: A broadband receiver that can be tuned to any desired channel.

B. A/V: Audio/visual.

C. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.

D. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, the signal is spread out over a wider band. The carrier frequency is the center frequency on any television channel.

E. CATV: Community antenna television. A communication system that simultaneously distributes several different channels of broadcast programs and other information to customers via a coaxial cable.

F. CCTV: Closed-circuit television.

G. CEA: Consumer Electronics Association.

H. db mV: Decibels relative to 1 mV across 75 ohms. db mV = 20 log 10(V(1)/V(2), where V(1) is the

measurement of voltage at a point having identical impedance to V(2) (0.001 V across 75 ohms).

I. Headend: The control center of the MATV system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "central retransmission facility."

J. I/O: Input/output.

K. MATV: Master antenna television. A small television antenna distribution system usually restricted to one or two buildings.

L. RF: Radio frequency.

M. User Interface: End point of Contractor's responsibility for Work of this Section. User interfaces are the [**terminal blocks to which the end user may connect coaxial cabling**][**75-ohm terminals on device plates**]<**Define user-interface points**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. MATV equipment.
2. Off-air antennas.
3. MATV headend components.
4. Distribution components.

B. Shop Drawings: For headend and distribution system. Include plans, elevations, sections, details, and attachments to other work.

1. Detail fabrication and installation details for television equipment.
2. Functional Block Diagram: Show single-line interconnections between components for headend and distribution system to user-interface points. Show cable types and sizes.
3. Dimensioned Plan and Elevations of Headend Equipment: Show access and workspace requirements.
4. Wiring Diagrams: For power, signal, and control wiring. Balanced twisted-pair or optical-fiber cable include cross connects, patch panels, and patch cords.

C. Samples: Full size for each outlet device plate in required colors and textures.

D. Design Calculations: Calculate signal attenuation budget and show calculated line and equipment losses for the system based on the functional block diagram, to show that proposed system layout can be expected to perform up to specification. Calculate signal strength from sources to headend input points for each antenna, satellite dish, and CATV grouping. Allowable losses between components and user interface shall be used to determine size and type of coaxial cable.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Include dimensioned plan and elevation views of components and enclosures. Show access and workspace requirements.

B. Equipment List: Include each piece of equipment and include model number, manufacturer, serial number, location, and date of original installation. Insert testing record of each piece of adjustable

equipment, listing name of person testing, date of test, and description of as-left set points.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For headend and distribution system to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Provide no fewer than one of each item listed below. Deliver extra materials to Owner.

1. Fuses: One for every [**10**]<**Insert number**> of each type and rating.
2. Splitters: One for every [**10**]<**Insert number**> installed.
3. MATV Distribution Power Amplifiers: One for every [**10**]<**Insert number**> of each type installed.
4. MATV Signal Traps: [**One**]<**Insert number**> for every [**10**]<**Insert number**> of each type used.
5. MATV Attenuators: [**One**]<**Insert number**> for every [**10**]<**Insert number**> of each type used.
6. Cable: **100 feet (30 m)** of each type used.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: System components shall be equipped and rated for the environments in which they are installed.

B. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components, except central-station control unit, installed in [**air-conditioned**][**temperature-controlled**] interior environments shall be rated for continuous operation in ambient conditions of [**36 to 122 deg F (2 to 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Interior, Uncontrolled Environment: System components installed in non-[**air-conditioned**][**temperature-controlled**] interior environments shall be rated for continuous operation in ambient conditions of [**0 to 122 deg F (minus 18 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to [**85 mph (137 km/h)**]<**Insert wind speed**>[**and snow cover up to 24 inches (610 mm) thick**].

1.8 COORDINATION

A. Coordinate size and location of raceway system and provisions for electrical power to equipment specified in this Section.

B. Coordinate Work of this Section with requirements of [**cable television service**][**direct broadcast**

satellite service][**an off-air antenna system**][**CCTV cameras and video recorders**] service provider.

C. Coordinate sizes and locations of concrete bases with actual equipment provided.

D. Coordinate installation of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. System shall consist of [**cable television service**][**direct broadcast satellite service**][**an off-air antenna system**][**CCTV cameras and video recorders**] and a coaxial cable distribution system.

1. Headend equipment shall consist of receiving antennas, satellites, and associated signal distribution amplification and equalization.
2. Distribution of direct broadcast satellite-service signals, which includes coordinating with Owner's selected service provider for installation of its dish-type antennas and processing the signals as needed to provide specified services combined into a single-feed point ready for connection into the distribution system. Obtain signal levels and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.
3. Distribution of cable television service signals, which includes coordinating with Owner's selected service provider for installation of cable to the service point ready for connection into the distribution system. Obtain signal levels and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.
4. Cable distribution system consisting of coaxial cables, user interfaces, signal taps and splitters, RF amplifiers, signal equalizers, power supplies, and required hardware, complying with EIA/ECA 310-E and CTA-2032-B and resulting in performance parameters specified in this Section. System shall be capable of distributing television channels according to CTA-542-D.

B. Hardware Requirements: Use plug-in, modular, solid-state electronic components. Mount amplifiers and other powered equipment in standard **19-inch (483-mm)** cabinet complying with EIA/ECA 310-E.

C. Off-Air Stations: Install antennas for the reception and distribution of selected stations.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum acceptable performance of distribution system at all user-interface points shall be as follows:

1. RF Video-Carrier Level: Between 3 and 12 db mV.
2. Relative Video-Carrier Level: Within 3 db to adjacent channel.
3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 db during a 60-minute period.
4. Carrier Level Stability, Long Term: Level shall not change more than 2 db during a 24-hour period.
5. Channel Frequency Response: Across any 6-MHz channel in the 54- to 220-MHz frequency range, referenced to video; signal amplitude shall be plus or minus 1 db, maximum.
6. Carrier-to-Noise Ratio: 45 db or more.
7. RF Visual Signal-to-Noise Ratio: 43 db or more.
8. Antenna Combiner Insertion Loss: 40 db maximum.
9. Signal Power Splitter and Isolation Tap Return Loss: 17 db maximum.
10. Cable Connectors Attenuation: Less than 0.1 db.

11. Cross Modulation: Less than minus 50 db.
12. Carrier-to-Echo Ratio: More than 40 db.
13. Composite Triple Beat: Less than minus 53 db.
14. Second Order Beat: Less than minus 60 db.
15. Terminal Isolation from Television to Television: 25 db, minimum.
16. Terminal Isolation between Television and FM: 35 db, minimum.
17. Hum Modulation: 2 percent, maximum.
18. RF FM Carrier Level: 13 to 17 db below video-carrier level.
19. FM Frequency Response: More than in the 88- to 108-MHz frequency range; signal amplitude is plus or minus 0.75 db, maximum.
20. FM Carrier-to-Noise Ratio: More than 24 db.

2.3 SYSTEM REQUIREMENTS

A. Components: Plug-in, modular, heavy-duty, industrial- or commercial-grade units.

B. Equipment: Silicon-based, solid-state, integrated circuit devices.

C. Power Supply Characteristics: Devices shall be within specified parameters for ac supply voltages within the range of 105 to 130 V.

D. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for that purpose. Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

E. Provide ac-powered equipment with integral surge protection devices complying with UL 1449.

F. RF and Video Impedance Matching: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 MATV EQUIPMENT

A. Description: Signal-source components, signal-processing and amplifying equipment, distribution components, and interconnecting wiring. System shall receive, amplify, process, and distribute signals to outlets for receiving sets. Equipment shall translate UHF channels to VHF channels before distribution to outlets.

B. Identification of Signal Sources Distributed:

1. <**Insert signal sources and basic service selection**>.

C. MATV System Qualitative and Quantitative Performance Requirements: Reception quality of color-television program transmissions at each system outlet from each service and source shall be equal to or superior than that obtained with performance checks specified in "Field Quality Control" Article, using standard, commercial, cable-ready, multiple A/V input color-television receivers.

2.5 OFF-AIR ANTENNAS

A. Antennas shall be tested, marked, and packaged, according to CTA-774-A, CEA-2028-B, and CEA-2032-B. Antennas shall be labeled according to CEA antenna mapping program.

B. Off-Air, Mast-Mounted Antennas: Weatherproof single-channel or broadband type, constructed of high-strength anodized aluminum and rated to survive in a [**100-mph (160-km/h)**]<**Insert speed**> wind, minimum.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Channel Master**]
    b. [**Winegard Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Channel Master**]
    b. [**Winegard Company**]
    c. <**Insert manufacturer's name**>

3. Elements: Internally dampened against mechanical vibration that may occur in service.
4. Ends of Crossarms and Elements: Sealed.
5. Mounting and Connecting Hardware: Corrosion proof.
6. Frequency Range: Matched to source frequencies.
7. CEA Reception Patterns: <**Insert reception pattern and number of antennas**>.
8. FM Antenna: Separate from the broadband antenna and the [**omnidirectional**][**directional**] antenna, with 2-db minimum gain.

C. Antenna-Supporting Structures: Prefabricated, hot-dip galvanized-steel units.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Channel Master**]
    b. [**Winegard Company**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Channel Master**]
    b. [**Winegard Company**]
    c. <**Insert manufacturer's name**>

3. Strength of Structure and Attachments: Adequate to withstand [**100-mph (160-km/h)**]<**Insert speed**> winds while supporting installed antennas.

4. Comply with 47 CFR 17 and TIA 222-G.
5. Comply with FAA AC 70/7460-1L.

2.6 MATV HEADEND COMPONENTS

A. Headend Equipment:

1. Components:

   a. Channel mixers.
   b. Processors.
   c. Broadband amplifier.
   d. Single-channel amplifiers.
   e. FM module.
   f. Combining networks.

2. Description: For receiving off-air television and FM signals and outputting the signals to cable distribution system. Equip coaxial down-leads of the off-air antennas with preamplifiers to send signals at strength required by headend. Headend component performance specified in this article is minimum acceptable; better performance may be required to comply with minimum acceptable system performance standard in "Performance Requirements" Article.
3. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARRIS**]
   b. [**ATX Networks Inc.**]
   c. [**Blonder Tongue Laboratories, Inc**]
   d. [**Cisco Systems, Inc.**]
   e. <**Insert manufacturer's name**>

4. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARRIS**]
   b. [**ATX Networks Inc.**]
   c. [**Blonder Tongue Laboratories, Inc**]
   d. [**Cisco Systems, Inc.**]
   e. <**Insert manufacturer's name**>

5. House units in standard **19-inch (483-mm)** electronic equipment cabinet complying with EIA/ECA 310-E.

B. Antenna Combiner: Directional coupler design network, combining up to eight antenna signals into a single output. Frequency response of the device shall be 5 to 400 MHz, and the insertion loss between input ports shall be not less than 40 db.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ATX Networks Inc.**]

b. [**Blonder Tongue Laboratories, Inc**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. <**Insert manufacturer's name**>

C. Down-Lead Preamplifiers: Antenna mast-mounted preamplifier, designed to boost antenna signal and contained in weatherproof housing; single-channel or broadband type. Install power supplies indoors at headend equipment, connected through power inserters to provide power to preamplifiers through the coaxial down-lead cable.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARRIS**]
b. [**ATX Networks Inc.**]
c. [**Blonder Tongue Laboratories, Inc**]
d. [**Channel Master**]
e. [**Leviton Manufacturing Co., Inc.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARRIS**]
b. [**ATX Networks Inc.**]
c. [**Blonder Tongue Laboratories, Inc**]
d. [**Channel Master**]
e. [**Leviton Manufacturing Co., Inc.**]
f. <**Insert manufacturer's name**>

3. Frequency Response: Plus or minus 0.75 db.
4. Minimum Input: Minus 20 db mV.
5. Return Loss: 14 db.
6. I/O Impedance: 75 ohms.

D. Channel Mixers: Use for nonadjacent channels only.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ATX Networks Inc.**]
    b. [**Blonder Tongue Laboratories, Inc**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. <**Insert manufacturer's name**>

3. Insertion Loss (Maximum 54 to 216 MHz): 2.5 db.
4. Return Loss: 14 db.
5. Out-of-Band Rejection: 12 db.
6. I/O Impedance: 75 ohms.

E. Processors: One for each channel to be translated.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARRIS**]
    b. [**ATX Networks Inc.**]
    c. [**Blonder Tongue Laboratories, Inc**]
    d. [**Cisco Systems, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ARRIS**]
    b. [**ATX Networks Inc.**]
    c. [**Blonder Tongue Laboratories, Inc**]
    d. [**Cisco Systems, Inc.**]
    e. <**Insert manufacturer's name**>

3. Bandwidth: 6 MHz.
4. Return Loss: 16 db, within the 6-MHz bandwidth.
5. Noise: Not more than 10 db at maximum gain.
6. Input Level Range, VHF: Minus 20 to plus 30 db mV.
7. Input Level Range, UHF: Minus 20 to plus 25 db mV.
8. Output Level Range: 50 to 60 db mV.
9. Carrier-to-Noise Ratio: Minus 57 db at plus 10-db mV input.
10. Automatic Gain Control: Plus or minus 1-db output variation for rated input level range variation.
11. Frequency Stability: Plus or minus 10 kHz over the operational temperature range.
12. Spurious Output: 60 db below the video carrier with video-carrier output level at plus 60 db mV and audio-carrier level at plus 45 db mV.
13. Adjacent Channel Rejection: Not less than 60 db.
14. I/O Impedance: 75 ohms.

F. Broadband Amplifier:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Leviton Manufacturing Co., Inc.**]
d. <**Insert manufacturer's name**>

3. Frequency Range: [**54 to 108, 174 to 220**][**54 to 220**] MHz.
4. Frequency Response: Plus or minus 1.0 db across passband.
5. Maximum Noise: 10 db.
6. Minimum Return Loss: 16 db.
7. I/O Impedance: 75 ohms.

G. Single-Channel Amplifiers:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Cisco Systems, Inc.**]
d. [**Leviton Manufacturing Co., Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ATX Networks Inc.**]
b. [**Blonder Tongue Laboratories, Inc**]
c. [**Cisco Systems, Inc.**]
d. [**Leviton Manufacturing Co., Inc.**]
e. <**Insert manufacturer's name**>

3. Frequency: 6 MHz for specified channel.
4. Frequency Response: Plus or minus 0.5 db.
5. Maximum Noise: 10 db.
6. Minimum Return Loss: 14 db.
7. Automatic Gain Control: Plus or minus 1-db output variation for rated input level range variation.
8. Skirt Rejection: Minus 26 db at plus or minus 5 MHz from channel center.
9. Sound Trap: Adjustable to 10 Vdb of attenuation of the sound carrier.
10. I/O Impedance: 75 ohms.

H. FM Module: One RF processor module for each station listed.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ATX Networks Inc.**]
    b. [**Blonder Tongue Laboratories, Inc**]
    c. [**Cisco Systems, Inc.**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ATX Networks Inc.**]
    b. [**Blonder Tongue Laboratories, Inc**]
    c. [**Cisco Systems, Inc.**]
    d. [**Leviton Manufacturing Co., Inc.**]
    e. <**Insert manufacturer's name**>

3. Frequency Range: Between 88 and 108 MHz.
4. Output Level: 52 db mV.
5. Output Level Control: Plus or minus 10 db.
6. Stability: 0.005 percent, crystal controlled.
7. Sensitivity: 3 mV for 30-db quieting.
8. Input Level: 60 mV, stereo.
9. Image Rejection: 901 db.
10. Passband: 200 kHz.
11. Selectivity: Plus or minus 150 kHz or less, at 30 db down. Plus or minus 250 kHz or less, at 50 db down.

I. Combining Network (Mixer): Combines the off-air television [**FM**][**CCTV**][**and**][**CATV**] signals into a single-broadband output. An output test point, a 75-ohm television jack, a mixer output step attenuator dual-pilot insertion network, and a removable mixer-to-trunk jumper are included.

1. Passband: As required by system performance.
2. Distortion:

    a. Not more than plus or minus 0.1 db over any 6-MHz segment.
    b. Not more than plus or minus 0.5 db over the 54- to 216-MHz frequency range.

3. Nominal Insertion Loss:

    a. 15 db maximum, channel input to single-system output.
    b. 13 db maximum, channel input to mixer output.
    c. 20 db maximum at test point (e.g., loss from trunk output).

4. Isolation between Any Two Inputs: 30 db.
5. I/O Impedance: 70 ohms.

2.7 DISTRIBUTION COMPONENTS

A. Signal Power Splitters and Isolation Taps: Metal-enclosed directional couplers with brass connector parts. Where installed in signal circuits used to supply cable-powered amplifiers, power throughput

capacity shall exceed load by at least 25 percent.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ATX Networks Inc.**]
    b. [**Leviton Manufacturing Co., Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ATX Networks Inc.**]
    b. [**Leviton Manufacturing Co., Inc.**]
    c. <**Insert manufacturer's name**>

3. Return Loss: 17 db.
4. RFI Shielding: 100 db.
5. Isolation: 25 db.
6. I/O Impedance: 75 ohms.

B. Distribution System Amplifiers: Powered by coaxial cable system and equipped with surge protection device and external test points to allow convenient signal monitoring.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARRIS**]
    b. [**ATX Networks Inc.**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ARRIS**]
    b. [**ATX Networks Inc.**]
    c. [**Leviton Manufacturing Co., Inc.**]
    d. <**Insert manufacturer's name**>

C. Cable System Power Supplies: Plug-in, modular construction, with surge, short-circuit, and overload protection.

D. Signal Traps: Packaged filters tuned to interference frequencies encountered in Project.

E. Attenuators: Passive, of fixed value, and used to balance signal levels.

F. Terminating Resistors: Enclosed units rated 0.5 W and matched for coaxial impedance.

G. Jack: Flush, female-type outlets, designed to mimic power duplex outlet; for mounting in standard outlet box; with metallic parts of anodized brass, beryllium copper, or phosphor bronze. Cable connector mounting shall be semirecessed, so its protrusion is flush with the plane of device plate.[**Feed-through-type cable connection shall not be used**][**, except in area housing a single tenant**][**, except within a single-dwelling unit**].

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ARRIS**]
    b. [**ATX Networks Inc.**]
    c. [**Canare Corporation of America**]
    d. [**Cisco Systems, Inc.**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ARRIS**]
    b. [**ATX Networks Inc.**]
    c. [**Canare Corporation of America**]
    d. [**Cisco Systems, Inc.**]
    e. [**Leviton Manufacturing Co., Inc.**]
    f. <**Insert manufacturer's name**>

3. Cable Connector: Female, Type F.
4. Wall Plates: Match materials and finish of power outlets in same space.
5. Attenuation: Less than 0.1 db.
6. Voltage Standing-Wave Ratio: Less than 1.15 to 1.

2.8 ENCLOSURES

A. Enclosures for Interior, Controlled Environments: NEMA 250, Type 1.

B. Enclosures for Interior, Uncontrolled Environments: NEMA 250, [**Type 3R**][**Type 4**][**Type 12**][**Type 12K**].

C. Enclosures for Exterior Environments: NEMA 250, [**Type 3**][**Type 3R**][**Type 3S**][**Type 4**][**Type 4X**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for antenna to verify actual locations of cable connections before antenna installation.

B. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where television equipment is to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install signal line surge suppressors on coaxial cables entering headend equipment space and at antenna-mounted amplifiers. Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

B. Install antenna towers, masts, and mountings on concrete bases. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 INSTALLATION OF ANTENNA AND HEADEND COMPONENTS

A. Mount headend equipment in electronic equipment cabinets recommended by manufacturer. Group related items in methodical sequence.

B. Arrange equipment to facilitate access for maintenance and to preserve headroom and passage space. Parts that require periodic service or maintenance shall be readily accessible. Headend components that require tuning adjustments shall be accessible from the front of equipment cabinets.

C. Align antenna elements to achieve maximum signal level and quality.

D. Antenna-Supporting Structure: Increase antenna height as required to obtain signal strength needed for specified system performance.

1. Attachment to Building:

a. Use **0.375-inch- (10-mm-)** minimum expansion anchors for masonry, and place anchors clear of grout or mortar joints.
b. Use **0.375-inch- (10-mm-)** minimum lag bolts for attachment to wood.

2. Lightning Protection: Comply with requirements in Section 264113 "Lightning Protection for Structures."

E. Antenna Cable Entrance: Use weatherproof entrance fittings, and seal at penetrations of the building envelope.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements.
2. Replace malfunctioning or damaged items.
3. Retest until satisfactory performance and conditions are achieved.
4. Prepare television equipment for acceptance and operational testing.
5. Use an agile receiver and signal strength meter or spectrum analyzer for testing.
6. Off-Air, Mast-Mounted Antenna Sources: Connect receiver to the down-lead of a 10-element, single-channel antenna, tuned and oriented to optimize reception for the channel and placed at system antenna's location. Alternatively, connect receiver to a single-channel video amplifier connected to the down-lead of the above single-channel antenna.
7. CATV Sources: Connect receiver to an agile demodulator or CATV set-top converter at CATV service entrance to the facility.
8. Satellite Earth-Station System Sources: Adapt receiver to the output of satellite-television receiver.
9. CCTV Sources: Connect receiver to the output of each CCTV signal source or the distribution amplifier associated with it.
10. Test Schedule: Schedule tests after pretesting has successfully been completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
11. Operational Tests: Perform tests of operational system to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
12. Distribution System Acceptance Tests:

    a. Field-Strength Instrument: Rated for minus 40-db mV measuring sensitivity and a frequency range of 54 to 812 MHz, minimum. Provide documentation of recent calibration against recognized standards.
    b. Signal Level and Picture Quality: Use a field-strength meter or spectrum analyzer, and a standard television receiver to measure signal levels and check picture quality at [**all**][**25 percent of**]<**Insert number or percentage**> user-interface outlets.

        1) Test the signal strength in db mV at 55[**, 151, 547,**] and 750 MHz.
        2) Minimum acceptable signal level is 0 db mV (1000 mV).
        3) Maximum acceptable signal level over the entire bandwidth is 15 db mV.
        4) Television receiver shall show no evidence of cross-channel intermodulation, ghost images, or beat interference.

13. Signal-to-Noise-Ratio Test: Use a field-strength meter to make a sequence of measurements at the output of the last distribution amplifier or of another agreed-on location in system. With system operating at normal levels, tune meter to the picture carrier frequency of each of the designated channels in turn, and record the level. With signal removed and input to corresponding headend amplifier terminated at 75 ohms, measure the level of noise at same tuning settings. With meter correction factor added to last readings, differences from first set must not be less than 45 db.
14. Qualitative and Quantitative Performance Tests: Demonstrate reception quality of color-television program transmissions at each user interface from each designated channel and source. Quality shall be equal to or superior than that obtained with performance checks specified below, using a standard, commercial, cable-ready, color-television receiver. Level and quality of signal at each outlet and from each service and source shall comply with the following Specifications when tested according to 47 CFR 76:

    a. RF video-carrier level.
    b. Relative video-carrier level.
    c. Carrier level stability, during 60-minute and 24-hour periods.

d. Broadband frequency response.
e. Channel frequency response.
f. Carrier-to-noise ratio.
g. RF visual signal-to-noise ratio.
h. Antenna combiner insertion loss.
i. Signal power splitter loss.
j. Cable connector attenuation.
k. Cross modulation.
l. Carrier-to-echo ratio.
m. Composite triple beat.
n. Second order beat.
o. Terminal isolation.
p. Terminal isolation between television and FM.
q. Hum modulation.
r. RF FM carrier level.
s. FM frequency response.
t. FM carrier-to-noise ratio.

C. Headend and distribution system will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Cap all unused connectors and seal weathertight.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain MATV equipment.

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
3. Demonstrate programming and tuning of satellite receivers.

END OF SECTION 27 41 33 00

SECTION 27 51 23 20 - COMMERCIAL INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes intercommunications and program systems with the following components:

1. Master station for manually switched systems.
2. Master station for microprocessor-switched systems.
3. Speaker-microphone stations.
4. Video-speaker-microphone stations.
5. Call-switch unit.
6. All-call amplifier.
7. Intercommunication amplifier.
8. Cone-type loudspeakers.
9. Horn-type loudspeakers.
10. Horn-type explosion-proof loudspeakers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Master station for manually switched systems.
2. Master station for microprocessor-switched systems.
3. Speaker-microphone stations.
4. Video-speaker-microphone stations.
5. Call-switch unit.
6. All-call amplifier.
7. Intercommunication amplifier.
8. Cone-type loudspeakers.
9. Horn-type loudspeakers.
10. Horn-type explosion-proof loudspeakers.

B. Shop Drawings: For intercommunications and program systems.

1. Include plans, elevations, sections, and [**mounting**][**attachment**] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include scaled drawings for master station [**and speaker-microphone station**]that detail built-in equipment.
4. Include diagrams for power, signal, and control wiring.

a. Identify terminals to facilitate installation, operation, and maintenance.
b. Single-line diagram showing interconnection of components.
c. Cabling diagram showing cable routing.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including luminaires, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
2. Elevation drawings, drawn to scale, on which wall-mounted items including luminaires, intercommunications components, windows, doors, access panels, wall finishes, trims, piping, and conduit are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For [**Installer**][**and**][**testing agency**].

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intercommunications and program systems to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. A record of Owner's equipment-programming option decisions.
b. Plans, drawn to scale, indicating location, designation, and connection of intercommunications system components.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 COORDINATION

A. Coordinate layout and installation of ceiling-mounted speaker microphones with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 COMMERCIAL INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ABB, Process Automation Business**]

2. [**Aiphone Corporation**]
3. [**Alpha Communications**]
4. [**CAME Americas Automation LLC**]
5. [**Comelit USA**]
6. [**Federal Signal Corporation**]
7. [**Jeron Electronic Systems, Inc**]
8. [**Stentofon; a brand of Zenitel USA**]
9. [**TOA Electronics, Inc**]
10. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ABB, Process Automation Business**]
2. [**Aiphone Corporation**]
3. [**Alpha Communications**]
4. [**CAME Americas Automation LLC**]
5. [**Comelit USA**]
6. [**Federal Signal Corporation**]
7. [**Jeron Electronic Systems, Inc**]
8. [**Stentofon; a brand of Zenitel USA**]
9. [**TOA Electronics, Inc**]
10. <**Insert manufacturer's name**>

2.2 SYSTEM DESCRIPTION

A. Equipment: Modular, using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power supplied at 110 to 130 V, 60 Hz without requirement of any external power conditioning equipment.

B. Expansion Capability: Increase number of stations in the future by [**25**]<**Insert number**> percent above those indicated without adding any internal or external components or main backbone cable conductors.

C. Integration: Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2.3 FUNCTIONAL DESCRIPTION OF MANUALLY SWITCHED SYSTEMS

A. Master Station:

1. Communicating selectively with other master and speaker-microphone stations by actuation of selector switches.
2. Communicating with all other stations by actuation of a single all-call switch.
3. Communicating with individual stations in privacy.
4. Include other master-station connections in a multiple-station conference call.
5. Access separate paging speakers or groups of paging speakers by actuation of selector switches.
6. Conversation override by a designated master station.
7. Visual monitoring of CCTV camera viewing area of video-speaker-microphone stations.
8. Remote door lock [**and access control**]function.

B. Speaker-Microphone Station:

1. Remote Monitoring: Initiated without a warning tone signal at monitored station. Designated speaker-microphone stations shall have a privacy switch to prevent another station from listening and to permit incoming calls.
2. Hands-free communication.
3. Calling master station by actuation of call switch.
4. Returns a busy signal to indicate that master station is already in use.
5. Free of noise and distortion during operation and when in standby mode.
6. Embedded [**HID**][**Weigand**]-formatted, proximity-type, access control card reader.
7. Remote door lock [**and access control**]function, controlled by master station.

C. Video-Speaker-Microphone Station:

1. Remote Monitoring: Initiated without a warning tone signal at monitored station. Designated speaker-microphone stations shall have a privacy switch to prevent another station from listening and to permit incoming calls. Illuminated signal to indicate video monitoring.
2. Color CCD video camera and illumination LED for low-light conditions.
3. Embedded [**HID**][**Weigand**]-formatted, proximity-type, access control card reader.
4. Remote door lock [**and access control**]function, controlled by master station.
5. Hands-free communication.
6. Calling master station by actuation of call switch.
7. Returns a busy signal to indicate that station is already in use.
8. Free of noise and distortion during operation and when in standby mode.

2.4 FUNCTIONAL DESCRIPTION OF MICROPROCESSOR-SWITCHED SYSTEMS

A. Master Station:

1. Communicating selectively with other master and speaker-microphone stations by dialing station's number on a 12-digit keypad.
2. Communicating simultaneously with all other stations by dialing a designated number on a 12-digit keypad.
3. Communicating with individual stations in privacy.
4. Include other master-station connections in a multiple-station conference call.
5. Access separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
6. Override any conversation by a designated master station.
7. Display selected station.
8. Video monitoring of all call stations on actuation of call switch.
9. Remote door lock [**and access control**]function.

B. Speaker-Microphone Station:

1. Remote Monitoring: Initiated without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
2. Hands-free communication.
3. Calling master station by actuation of call switch.
4. Return a busy signal to indicate that station is already in use.
5. Free of noise and distortion during operation and when in standby mode.
6. Embedded [**HID**][**Weigand**]-formatted, proximity-type, access control card reader.

C. Video-Speaker-Microphone Station:

1. Remote Monitoring: Initiated without a warning tone signal at monitored station. Designated

speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls. Illuminated signal to indicate video monitoring.
2. Color CCD video camera and illumination LED for low-light conditions.
3. Embedded [**HID**][**Weigand**]-formatted, proximity-type, access control card reader.
4. Remote door lock [**and access control**]function, controlled by master station.
5. Hands-free communication.
6. Calling master station by actuation of call switch.
7. Returns a busy signal to indicate that station is already in use.
8. Free of noise and distortion during operation and when in standby mode.

2.5 MASTER STATION FOR MANUALLY SWITCHED SYSTEMS

A. Station-Selector and Talk-Listen Switches: Heavy-duty type with gold-plated contacts rated for five million operations.

B. Volume Control: Regulates incoming-call volume.

C. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.

D. Tone Annunciation: Momentary audible tone signal announces incoming calls.

E. Speaker Microphone: Transmits and receives calls.

F. Handset with Hook Switch: Telephone type with **18-inch- (450-mm-)** long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

G. Color LCD video screen for monitoring of CCD cameras integral to call stations.

H. Equipment Cabinet: Comply with ECA/EIA-310-E. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment.

2.6 MASTER STATION FOR MICROPROCESSOR-SWITCHED SYSTEMS

A. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.

B. Volume Control: Regulates incoming-call volume.

C. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.

D. Tone Annunciation: Momentary audible tone signal announces incoming calls.

E. Color LCD video screen for monitoring of CCD cameras integral to call stations.

F. Handset with Hook Switch: Telephone type with **18-inch- (450-mm-)** long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

G. Reset Control: Cancels call and resets system for next call.

H. Equipment Cabinet: Comply with ECA/EIA-310-E. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.

2.7 SPEAKER-MICROPHONE STATIONS

A. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.

B. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.

C. Back Box: Two-gang galvanized steel with **2-1/2-inch (64-mm)** minimum depth.

D. Speaker: **3 inches (76 mm)**, **2.3 oz. (65 g)** minimum; permanent magnet.

E. Tone Annunciation: Recurring momentary tone indicates incoming calls.

F. Call Switch: Mount on faceplate. Permits calls to master station.

G. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.

H. Handset with Hook Switch: Telephone type with **18-inch- (450-mm-)** long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

2.8 VIDEO-SPEAKER-MICROPHONE STATIONS

A. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.

B. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.

C. Back Box: Custom size provided by manufacturer for flush mounting of station device.

D. Wide-angle camera with digital pan-tilt-zoom functions and automatic light adjustment to compensate for varying ambient light levels. Camera lens shall provide a minimum viewing angle of 170 degrees horizontal and 100 degrees vertical.

E. LED Lamp: Indicates video activation and provides illumination during low-light conditions.

F. Speaker: **3 inches (76 mm)**, **2.3 oz. (65 g)** minimum; permanent magnet.

G. Tone Annunciation: Recurring momentary tone indicates incoming calls.

H. Call Switch: Mount on faceplate. Permits calls to master station.

2.9 CALL-SWITCH UNIT

A. Enclosure: Single-gang box with stainless-steel faceplate.

B. Call Switch: Momentary contact signals system that a call has been placed.

C. Privacy Switch: Prevents transmission of sound signals from station to system.

D. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.

E. Handset with Hook Switch: Telephone type with **18-inch- (450-mm-)** long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

2.10 ALL-CALL AMPLIFIER

A. Output Power: 70-V balanced line. [**80 percent of the sum of wattage settings of connected**]<**Insert wattage**> for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.

B. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.

C. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.

D. Frequency Response: Within plus or minus 3 dB from 70 to 12,000 Hz.

E. Output Regulation: Maintains output level within 2 dB from full to no load.

F. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.

G. Amplifier Protection: Prevents damage from shorted or open output.

2.11 INTERCOMMUNICATION AMPLIFIER

A. Minimum Output Power: [**2**]<**Insert number**> W; adequate for all functions.

B. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.

C. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.

D. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.

E. Output Regulation: Maintains output level within 2 dB from full to no load.

F. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.

G. Amplifier Protection: Prevents damage from shorted or open output.

2.12 CONE-TYPE LOUDSPEAKERS

A. Minimum Axial Sensitivity: 91 dB at **3 feet (1 m)**, with 1-W input.

B. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.

C. Minimum Dispersion Angle: 100 degrees.

D. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

E. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least **0.0478-inch (1.2-mm)** steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant, or wall mounting; with relief of back pressure.

F. Baffle: For flush speakers, minimum thickness of **0.032-inch (0.8-mm)** aluminum [**brushed to a satin sheen and lacquered**][**with textured white finish**]<**Insert finish**>.

G. Vandal-Proof, High-Strength Baffle: For [**flush**][**surface**]-mounted speakers, self-aging cast aluminum with tensile strength of **44,000 psi (303 MN/sq. m)**, **0.025-inch (0.65-mm)** minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.

H. Size: **8 inches (200 mm)** with **1-inch (25-mm)** voice coil and minimum **5-oz. (140-g)** ceramic magnet.

2.13 HORN-TYPE LOUDSPEAKERS

A. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.

B. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.

C. Minimum Power Rating of Driver: 15 W, continuous.

D. Minimum Dispersion Angle: 110 degrees.

E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

2.14 HORN-TYPE EXPLOSION-PROOF LOUDSPEAKERS

A. Speakers shall be all-metal construction; complete with universal mounting brackets.

B. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.

C. Frequency Response: Within plus or minus 3 dB from 300 to 12,000 Hz.

D. Minimum Power Rating of Driver: [**30**][**60**] W, continuous.

E. Minimum Dispersion Angle: [**95**][**60 by 120**] degrees.

F. Line Transformer: Internally mounted and factory installed, power rating equal to speaker's, and at least four level taps.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method, Raceways: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method, Concealed: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
5. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
2. Suspend cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceiling by cable supports not more than [**60 inches (1524 mm)**]<**Insert dimension**> apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, video, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least **12 inches (300 mm)** apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.3 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

D. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Mounting of Stations: Surface mount at **54 inches (137.2 cm)** above finished floor to center of station unless otherwise indicated.

3.4 INSTALLATION OF GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 SYSTEM PROGRAMMING

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice.
2. After installing intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Test originating station-to-station[**, all-call, video display, and page**] messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
4. Frequency Response Test: Determine frequency response of two transmission paths[**, including all-call and paging,**] by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a

1000-Hz signal. Measure signal-to-noise ratio at[**paging**] speakers.
b. Repeat test for four speaker microphones[**and for each separately controlled zone of paging loudspeakers**].
c. Minimum acceptable ratio is 35 dB.

6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into[**each paging and all-call amplifier, and**] a minimum of two selected intercommunication amplifiers. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
7. [**Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at three locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.**]
8. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

F. Intercommunications and program systems will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service[**and initial system programming**].

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.
3. <**Insert startup steps if any**>.

3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the intercommunications and program systems.

1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining the system and equipment.

END OF SECTION 27 51 23 20

Task	Specification	Specification Description
27 51 43 00	26 33 43 00a	Public Address Systems
27 51 43 00	27 41 23 00	Educational Intercommunications and Program Systems

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SECTION 27 52 23 00 - NURSE CALL CODE BLUE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Visual/tone nurse-call system.
2. Audiovisual/voice nurse-call system.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Visual/tone nurse-call system.
2. Audiovisual/voice nurse-call system.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment cabinets and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
3. Station Installation Details: For built-in equipment, dimensioned and to scale.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For nurse-call equipment to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: All colors for corridor dome lights and zone lights equal to [**20**]<**Insert number**> percent of amount installed.
2. Fuses: One for every 10 of each type and rating, but no fewer than <**Insert quantity**> of each.
3. Printed Circuit Boards: Each kind, equal to [**10**]<**Insert number**> percent of amount installed, but

no fewer than one unit.
4. Master-Station Privacy Handset: [**One**]<**Insert number**>.
5. System program backup software.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.

C. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty for batteries applies to materials only, on a prorated basis for specified period.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:

a. Nickel-Cadmium Batteries, Lithium Batteries, and Wet-Cell Batteries:

1) Full Warranty: [**Five**]<**Insert number**> years.
2) Pro Rata: [**15**]<**Insert number**> years.

1.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for [**two**]<**Insert number**> years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide [**30**]<**Insert number**> days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 NURSE-CALL SYSTEM GENERAL REQUIREMENTS

A. Station Zones: Able to program [**256**]<**Insert number**> station zones for each master station in the network with [**eight**]<**Insert number**> priority levels and addressable visual and audible annunciation of audible devices such as smoke detectors and door contacts.

B. System shall provide integrated and centralized "Code Blue" and "Staff Emergency" calls.

C. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities adequate to increase the number of stations in the future by [**25**]<**Insert number**> percent above those indicated without adding internal or external components or main trunk cable conductors.

D. Existing System Compatibility: Functionally and electrically compatible with existing system so components and wiring operate as an extension or upgrade of the existing system and existing or upgraded functional performance of the existing system applies to the entire final system. Colors, tones, types, and durations of signal manifestation shall be common among new and existing systems.

E. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.

F. Equipment: Microprocessor, electronic, modular.

G. Master Nurse-Call Station: Programmed via a PC.

H. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.

I. Telephone Interface: Permit use of wired and wireless telephones to execute nurse-call master station functions.

J. Third-Party Pager Interface: Programmable to send tone, numeric, and alphanumeric message to pocket pagers or personal digital assistants and to use industry standard-protocol, RS-485 interface.

2.2 VISUAL/TONE NURSE-CALL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aiphone Corporation**]
2. [**Alpha Communications**]
3. [**Ascom North America**]
4. [**Cornell Communications, Inc**]
5. [**Intego Systems, Inc.**]
6. [**Intercall Systems, Inc**]
7. [**Jeron Electronic Systems, Inc**]
8. [**Rauland-Borg Corporation**]
9. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
10. [**TekTone Sound & Signal Mfg., Inc.**]
11. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aiphone Corporation**]
2. [**Alpha Communications**]
3. [**Ascom North America**]
4. [**Cornell Communications, Inc**]

5. [**Intego Systems, Inc.**]
6. [**Intercall Systems, Inc**]
7. [**Jeron Electronic Systems, Inc**]
8. [**Rauland-Borg Corporation**]
9. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
10. [**TekTone Sound & Signal Mfg., Inc.**]
11. <**Insert manufacturer's name**>

C. Operational Requirements:

1. Patient Station Call: Lights a steady call-placed lamp on the station, steady lamps in the zone light and corridor dome light associated with the patient's room, and steady lamps at the central annunciator and other system display devices and displays message on master and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the respective annunciator and master and staff/duty stations. Legends at the central annunciator and master station identify the calling station.
2. Pull-Cord-Call Station Call: Flashes a call-placed lamp on the station and distinctive-color lamps in the zone light and corridor dome light and at the central annunciator and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the central annunciator and master and staff/duty stations. A legend at the master station identifies the calling station, priority as programmed, and bed identification.
3. Emergency-Call Station Call: Produces the same responses as pull-cord-call station calls except rapidly flashing red emergency digital display and tone repetition rates are more frequent, tone frequency is higher, and lamps in the zone light and corridor dome light are a different color. Indicator lamps may be extinguished and the system reset only at the calling station. Displays message on pocket pagers, sounds programmed tone on phones, and displays message on display equipped phones.
4. System Reset: Operating reset button at the originating station cancels signals associated with the call. Illuminates a green digital display on the patient station and log presence on the master station.
5. Cord-Set Removal: Initiates a patient station call when the cord set is removed from the jack in the patient station faceplate. Displays location and "cord removed" message on master station, pocket pagers, and display equipped phones. Inserting a cord-set plug or a dummy plug into the jack and operating the station reset button resets the call.
6. Patient Control Unit: Controls entertainment volume and channel selection. Nurse button on the unit initiates a patient station call. Integral speaker reproduces entertainment sound.
7. Emergency Bath Station Call: Illuminates the digital display on the emergency bath station; rapidly flashes white dome lamp; displays location, priority, and bath on master station; and sounds programmed tone on master station display equipped phones and pocket pagers.
8. Staff/Duty Station Operation: Operation shall be identified to patient station except the message staff shall display on all devices when the staff call button is activated.
9. Privacy Key Activation: When privacy key is activated on patient station, the system shall disconnect the patient station microphone and slowly flash yellow privacy digital display on the patient station. Displays "privacy" on master station when selecting this room/bed.

D. Central Annunciator:

1. Lamp type.
2. Lamp Legends: Machine lettered and legible from a distance of at least **48 inches (1200 mm)** when a call is present. Legend shall identify initiating station and priority of call.
3. Power-on Indicator: Digital, or push-to-test switch.
4. Audible Signal: Electronic tone.

E. Central Equipment Cabinet:

1. Lockable metal.
2. Houses power supplies, controls, terminal strips, and other components.
3. Power-on indicator lamp.
4. Battery Backup Unit: Sealed [**nickel-cadmium, wet-cell**]<**Insert type**> battery supplies power through an automatic switch when normal power fails, for a period of not less than [**six**]<**Insert number**> minutes at rated output. System shall lose no unanswered calls or calls in progress during the transfer operation.

    a. Automatic retransfer to normal power, after a [**15**]<**Insert number**>-minute time delay.
    b. Two-rate battery charger with an automatic trickle rate and a recharge rate.

F. Single-Patient Station: Call-placed lamp, reset push button, and polarized receptacle matching cord-set plug; mounted in a single faceplate.

G. Dual-Patient Station: Single call-placed lamp, single reset push button, and two polarized receptacles matching cord-set plug; mounted in a single faceplate.

H. Ambulatory-Patient Station: Call push-button switch, call-placed lamp, and reset push button; mounted in a single faceplate.

I. Staff/Duty Stations: A minimum of two call lamps, one for routine calls and one for emergency calls; and an audible tone signal device.

2.3 AUDIOVISUAL/VOICE NURSE-CALL SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aiphone Corporation**]
2. [**Alpha Communications**]
3. [**Ascom North America**]
4. [**BEST HEALTHCARE COMMUNICATIONS**]
5. [**Cornell Communications, Inc**]
6. [**Intego Systems, Inc.**]
7. [**Intercall Systems, Inc**]
8. [**Jeron Electronic Systems, Inc**]
9. [**Rauland-Borg Corporation**]
10. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
11. [**TekTone Sound & Signal Mfg., Inc.**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aiphone Corporation**]
2. [**Alpha Communications**]
3. [**Ascom North America**]
4. [**BEST HEALTHCARE COMMUNICATIONS**]
5. [**Cornell Communications, Inc**]
6. [**Intego Systems, Inc.**]
7. [**Intercall Systems, Inc**]
8. [**Jeron Electronic Systems, Inc**]
9. [**Rauland-Borg Corporation**]
10. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]

11. [**TekTone Sound & Signal Mfg., Inc.**]
12. <**Insert manufacturer's name**>

C. Operational Requirements:

1. Station Selection from Master Station: Capable of selectively communicating with other stations or groups of stations on its system by touch screen, mouse click, or manual switch; and capable of programming up to [**256**]<**Insert number**> stations for each master station in the network.
2. Master Station Privacy: Capable of conversing with individual stations in complete privacy.
3. Called Station:

    a. Capable of hands-free and two-way conversation.
    b. Pressing "talk/listen" key shall cause the annunciation tone to cease.
    c. Pressing "cancel" key terminates normal calls and conversations.
    d. Terminating of high-priority level [**1**][**2**][**3**][**or**][**4**] shall not be allowed except at calling station location and shall send "remind" message if the call is not acknowledged at point of origin in programmed time frame.

4. Annunciation:

    a. At the master station, a programmable tone announces an incoming call; an annunciator light or digital display identifies the calling station and indicates the priority of the call.
    b. Call type indications include alarm assist, bath, bed, code, communication fault, cord out, door, emergency, and fire.
    c. Memory lamps or lighted displays identify stations selected for outgoing calls.

5. System Reset at Master Station: A normal, incoming call can be canceled, associated lights and audible tones extinguished, and the system reset when the station switch is returned to the normal position.
6. Patient Station Calls:

    a. Lights the call-placed lamp at patient station, zone, and corridor dome lights.
    b. Sounds a tone and lights the call lights at staff/duty stations and actuates annunciation at the master station.
    c. When the calling station is selected at the master station, the patient can converse with the master station without moving and without raising or directing the voice.
    d. During voice communications, entertainment audio at the calling station is automatically muted.

7. Pull-Cord-Call Station Calls and Emergency-Call Station Calls:

    a. Lights call-placed lamp and corridor dome light and flashes zone light.
    b. Master station tone pulses and annunciator light for that room flashes.
    c. When master station acknowledges the call by touch screen or switch, the tone stops but lights continue to flash until the call is canceled at the initiating point.

8. Code Blue and Staff/Duty Station Calls:

    a. Lights the call-placed lamp at the station and actuates annunciation at the master station.
    b. When the called station is selected at the master station, the caller and the master station operator can converse.
    c. Code Blue: Unique sound and light pattern indicating the highest priority emergency.
    d. Staff Station: Unique sound and light pattern indicating an emergency.
    e. Duty Station: Sound and light pattern indicating a call to the nurse station.

9. Handset Operation: Lifting the handset on master station disconnects speaker/microphone and transfers conversation to the handset.
10. Station Privacy: No patient or staff/duty station can be remotely monitored without lighting a warning lamp at the monitored station.
11. Patient Station Cord-Set Removal:

    a. A patient station call is initiated as described above when a patient station cord-set plug is removed from the jack in the station faceplate.
    b. Tone stops but lights continue to flash until the call is canceled at the initiating point or the plug is reinserted or replaced with a dummy plug when the master station call button for the station is pressed.

12. Patient Control Unit:

    a. Controls entertainment volume and channel selection.
    b. Speaker is used for both nurse communication and entertainment sound.
    c. Entertainment sound is automatically muted when station is communicating with master station.
    d. Nurse button on the unit initiates a patient station call.

13. Selective Paging: Master station is capable of initiating a message to selected groups of stations or speakers simultaneously by using station group switches.
14. Staff Reminder:

    a. Master station can initiate a staff reminder that a patient requires direct staff response by operating a reminder control while in contact with the patient station.
    b. This reminder will light a distinctive-color lamp in the corridor dome light at the patient's room and in the appropriate zone lights.
    c. Reminder calls are canceled by operating a staff reminder cancel switch in the patient's room.

15. Call Priority Indication:

    a. Capable of [**eight**]<**Insert number**> call priority levels in addition to normal.
    b. Call priority switch near each patient station, or integral with the master station, shall control priority status of the call transmitted by individual stations.
    c. Switch selects one of the following status levels:

        1) Normal: No change to the normal call initiation and canceling sequence.
        2) Emergency: Call initiation produces signals and indications identical to those of emergency-call stations. Indicator lamps are extinguished and the system is reset only at the originating station.
        3) Priority: System response is the same for emergency status except voice communication between the master station and the calling station is locked in from the time of call initiation until the system is reset at the originating station.

16. Additional Call:

    a. Waiting display window on the master station similar to current call window displays incoming calls.
    b. Master station shall have a call-overflow indicator when incoming calls exceed <**Insert number**> calls.
    c. System shall store unlimited number of incoming calls.
    d. System shall be capable of automatically answering incoming calls in order of priority.

17. Calling Intercom Stations:

a. Master station shall be capable of calling any intercom station using the handset or the hands-free speaker/microphone.
b. Receipt of a call at the intercom station shall be preceded by an optional pre-announce tone.
c. If there is a call in process, system shall place the active call on automatic hold while the new call is placed, then reestablish the previous call when the new call has ended.

18. Privacy Override:

a. Temporarily deactivates the "Privacy" mode of a called station by calling the station and instructing the called party to press the call-cord button.
b. On completion of the conversation, the called station shall automatically return to the "Privacy" mode.
c. When in "Privacy" mode, a called station shall be capable of hearing the master station; however, the master station shall not be capable of hearing the called station; a privacy message shall be indicated on the master station display.

19. Master-Station-to-Master-Station Calls:

a. Master stations shall be capable of calling other master stations using the handset.
b. Calls from master stations shall be answered using the handset only.
c. Busy master stations shall be indicated by a master station intercom busy tone.

20. Voice Paging:

a. Capable of voice paging to all stations using a single "All Call" key.[**The page shall be preceded by an optional pre-announce tone.**]
b. Capable of voice paging to eight user-defined groups of stations by selecting the group and then the "All Call" key.[**The page shall be proceeded by a pre-announce tone.**]
c. Capable of voice paging to all staff/duty stations and all patient stations where staff has registered presence using a single "Public Address (PA)/Staff" key.[**The page shall be proceeded by a pre-announce tone.**]
d. Capable of voice paging through a third-party PA system.
e. Capable of including or excluding any station from the voice paging function(s).
f. Automatically places an active station call on hold during any page and reestablishes the connection at the end of the page.
g. Automatically cancels a page if the talk mode is inactive for more than 15 seconds.

21. Station Monitor:

a. An audio monitor feature shall allow a user to sequentially or simultaneously listen to one or all stations that are included in the user-created list.
b. Master station display shall indicate which station is being monitored when in sequential mode.
c. The dwell time each station is monitored shall be user programmable.
d. The user shall be able to stop the monitoring sequence by activating a "pause" key.
e. The user shall be able to manually sequence through stations using a "next" key.

22. Night Service:

a. Functions shall be adaptable for nighttime staffing levels, patient traffic, and day/night operations.
b. Staff Follow:

1) Capable of locating roving staff; forwarding visual and audible annunciation of

incoming calls to station(s) where personnel have registered presence.
2) Master station shall display locations where staff have registered presence.
3) Incorporates a programmable timer that automatically cancels a forgotten staff presence registration.

c. Tones:

1) Deactivates audio signals from a duty station and mini-master display telephones.
2) Capable of changing the tone volume at the master and duty stations.
3) Satellite function shall permit the user to deactivate audio signals from duty stations and other remote annunciator devices.

d. Day/Night Transfer:

1) Permits one nurse station to take control of all or individually selected bed call cords from another nurse station. It shall be possible to view transfer status of a nurse station.
2) Transfer Modes: As a minimum, include the following three transfer modes to allow one nurse station to take control or share calls and operations from another nurse station:

a) Parallel Transfer Mode: Permits both nurse stations to share all calls and operations.
b) Supervised Transfer Mode: Permits the transferred nurse station to share all calls and operations with the controlling nurse station; however, the controlling nurse station calls are not shared with the transferring station.
c) Capture Transfer Mode: Transfers all calls and operations from the transferred nurse station to the controlling nurse station.
d) Transferred station shall have no control over calls, and its display shall indicate calls have been transferred to another station.

3) Patient Swing Modes: As a minimum, include the following two patient swing modes to allow one nurse station to take control or share calls from one or many calls from another nurse station:

a) Supervised Transfer Mode: Permits the transferred calls to be shared with the controlling nurse station.
b) Capture Transfer Mode: Transfers all calls from the call cord from the transferred nurse station to the controlling nurse station.
c) Transferred station has no control over those transferred calls.

23. Service Request:

a. Permits users to assign a service request to a substation, at programmable priority level.
b. Displays service request on the nurse station display and light the green flashing corridor lamp at the respective substation and automatically generate a service reminder request.
c. Cancels service requests only at the initiating point.
d. Recall calls shall sound and be displayed at the master station if the service request has not been cancelled at the initiating point within the programmed period of time.

24. Call Reminder Function:

a. Automatically generates a reminder call for a patient- or staff-initiated, high-priority [**2**][**3**][**or**][**4**] request that has had the call tones silenced, allowing time to physically attend to the request and cancel the call at the initiating point.
b. Regenerated calls shall display the same tones and visual indications and priority as the

original call and shall also display a "regenerated call" message.
c. Capable of manually adding low-priority calls to the reminder list.
d. "Call Reminder" function and reminder timer shall be programmable by call priority.

25. Hide Function: Prevents a selected station from displaying calls or generating tones on the nurse station.
26. Door Control Function: Capable of being programmed to enable the user to remotely activate electric door locks.
27. Test and Diagnostics Feature:

    a. Able to automatically diagnose system faults and categorize them as warnings, communication errors, or fatal errors.
    b. Warnings shall indicate possible system problems.
    c. Communication errors shall indicate the inability of the master station to communicate with a substation or another nurse-call station.
    d. Fatal errors shall indicate a major hardware or software failure.

28. User-Configured System Programming - Access Code Not Required:

    a. Patient call-cord priority levels.
    b. Monitor list.
    c. "All Call" list.
    d. Master station communication parameters (volume, filtering, talk/listen, sensitivity).
    e. Master and duty station call annunciation tone volume.
    f. Date/time.
    g. Staff-follow operating mode.
    h. Transfer type.
    i. Pocket pager list assignment.
    j. Presence mode.

29. User-Configured System Programming - Access Code Required:

    a. Master station number.
    b. Room device type.
    c. Room number.
    d. Bed number.
    e. Bed alpha or numeric.
    f. Reminder duration.
    g. Staff presence registration cancel duration.
    h. Display language.
    i. Paging group assignment(s).
    j. Zone group assignments.
    k. Monitoring duration.
    l. Pocket pager number.
    m. Call tone assignment by priority.
    n. Pretone activation.
    o. Call tones minimum volume.
    p. Clock mode (12 h/24 h).

D. Master Station:

1. Speaker/microphone unit with operating controls.
2. Indicator lamps with legends or by digital display designate identification and priority of calling stations and called stations.
3. Pulse rate of incoming-call lights denotes priority of calls awaiting response.

4. Station Selection Controls: Touchpad select stations for two-way voice communications.
5. Signal Tones: Programmable to announce incoming calls.
6. Pulse rate and frequency of tone identify the highest priority call awaiting response at one time.
7. Volume Control: Regulates incoming-call volume.
8. Privacy Handset with Hook Switch: Of the type that does not require push-to-talk switch attached to each station unless otherwise indicated.
9. Staff Reminder Control: Initiates flashing of corresponding corridor dome lights for patients requiring service. Permits scanning equipment to indicate which patients are currently in reminder status.
10. Call Priority Selection: Controls associated with patient-station selection switches determine the priority displayed when a call is initiated at a patient station.

E. Central Equipment Cabinet:

1. Lockable metal.
2. Houses amplifiers, tone generators, power supplies, controls, terminal strips, and other components.
3. Amplifier: With fidelity and overall gain necessary to achieve the sound-transmission and reproduction characteristics specified, considering interoperability with the installed speakers/microphones and wiring.

    a. Power Output: Not less than 3 W at a total harmonic distortion not exceeding 5 percent.
    b. Hum and Noise: 60 dB below full output with normal input open.
    c. Volume Control: Concealed within the amplifier unit to control the volume of sound reproduced at all stations.
    d. Protection: Circuit to prevent damage to the amplifier in case of shorted or open circuit.

4. Selective Paging Amplifiers: Plug-in card mounted in central equipment cabinet, rated 15 W.
5. System Power Supply:

    a. 24-V dc for operation of the call system.
    b. Equipment Rating: Suitable for continuous operation between **32 and 120 deg F (0 and 49 deg C)**, from a primary line voltage between 105- to 125-V ac, 60 Hz.
    c. Output: Regulated 24-V dc with protection against overloads. Line-to-load regulation shall not exceed 2-1/2 percent with ripple and noise remaining below the 10-mV, rms level.
    d. Overload Protection: Electronic fold-back circuit set to limit the volt-ampere output to less than 100 VA during overloaded or shorted output. Restore power output automatically on removal of overload without resetting circuit breakers or replacing fuses.

6. Power-on indicator lamp.
7. Surge Protector Device: Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" for auxiliary panel suppressors, with [**digital indicator lights for power and protection status**]<**Insert accessories**>.
8. Battery Backup Unit: Sealed [**nickel-cadmium, wet-cell**]<**Insert type**> battery supplies power through an automatic switch when normal power fails, for a period of not less than [**six**]<**Insert number**> minutes at rated output.

    a. Automatic retransfer to normal power, after a [**15**]<**Insert number**>-minute time delay.
    b. Two-rate battery charger with an automatic trickle rate and a recharge rate.

F. Speaker/Microphones:

1. Type: Permanent-magnet, dynamic or ceramic, protected against dust and humidity.
2. Sound Reproduction: Sound level of 90 dB plus or minus 3 dB at a distance of **48 inches (1220 mm)** on the axis without overdriving or distorting any frequencies between 300 and 3000 Hz when installed in an enclosure or in the pillow speaker.

3. Power Handling Capacity: Not susceptible to damage from overdriving within the range of power available from the amplifier.
4. Impedance Matching: Coordinated and matched to the input and output circuits of the amplifier, both for single connection and for group monitoring, to provide the sound reproduction specified. Subsystems or components shall not be combined, which could cause unacceptable distortion such as feedback between pillow speakers and unmuted room speaker/microphone combinations. This protection shall extend throughout the entire range of operation (volume control) of all components.

G. Single-Patient Station: Speaker/microphone with **2-inch (50-mm)** dynamic cone, a polarized receptacle to match the cord-set plug, monitor lamp, reset switch, and call-placed lamp; assembled under a single faceplate.

H. Dual-Patient Station:

1. Speaker/microphone with **2-inch (50-mm)** dynamic cone, two polarized receptacles to match cord-set plugs, monitor lamp, and reset switch; assembled under a single faceplate.
2. Single call-placed lamp serves both beds.
3. Dual call-placed lamps, one for each bed.

I. Staff/Duty Stations: Audible call-tone signal device, speaker/microphone with **2-inch (50-mm)** dynamic cone, monitor lamp, reset switch, routine-call lamp, emergency-call lamp, and call push button; assembled under a single faceplate.

J. Code Blue Station: Audible call-tone signal device, speaker/microphone with **2-inch (50-mm)** dynamic cone, monitor lamp, reset switch, Code Blue emergency-call lamp, and call push button; assembled under a single faceplate.

K. Ambulatory-Patient Station: Speaker/microphone with **2-inch (50-mm)** dynamic cone, monitor lamp, reset switch, call-placed lamp, and call push button; assembled under a single faceplate.

L. Selective Paging Speakers: **8-inch (200-mm)** cone type with **1-inch (25-mm)** voice coil and minimum **5-oz. (140-g)** ceramic magnet, multitap matching transformer, flush-mounted steel back-box, and white enamel-finished metal ceiling grille.

M. Call Priority Switch Station: Three-position, tamper-resistant priority selection switch. Positions designated by labeling "Normal," "Emergency," and "Priority."

N. Staff Reminder Cancel Switch Station: Momentary contact.

2.4 SYSTEM COMPONENTS

A. Emergency-Call Station: Locking-type push button, labeled "Push to Call Help"; reset trigger to release push button and cancel call; and call-placed lamp, mounted in a single faceplate.

B. Emergency-Bath Station:

1. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "URGENT" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Water resistant and able to withstand routine cleaning and chemical disinfectants.
5. Uses magnetic reed switch technology for reliability and corrosion resistance.

6. Mounts on a single-gang electrical box wire to the respective patient station or input controller.

C. Code Blue Station:

1. Consists of a sliding, chemical-resistant, ABS blue fascia marked with the word "CODE" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Water resistant and able to withstand routine cleaning and chemical disinfectants.
5. Uses magnetic reed switch technology for reliability and corrosion resistance.
6. Mounts on a single-gang electrical box wire to the respective patient station or input controller.

D. Staff, Emergency Station:

1. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "EMERGENCY" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Mounts on a single-gang electrical box wire to the input controller.

E. Pull-Cord-Call Station:

1. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
2. Reset trigger.
3. Call-placed lamp.
4. Water-resistant construction.

F. Patient Control Unit:

1. Equipped with plug and **96-inch- (2400-mm-)** long white cord.
2. Ethylene oxide, sterilizable.
3. Light-Control Switch: Arranged for independent on-off control of patient's up and down light.
4. Integral Speaker: **2 inches (50 mm)**, with **0.35-oz. (9.9-g)** magnet, rated 0.2 W.
5. Controls: Speaker volume, TV control, and nurse call.
6. Housing: High-impact white plastic.
7. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
8. Quantity: 12 units for every 10 patient beds.

G. Call-Button Cord Set:

1. Plug and **72-inch (1800-mm)** white cord; cord set shall be resistant to medical gas environment equipped with momentary-action, call-button switch.
2. Ethylene oxide, sterilizable.
3. Washable cord.
4. Palladium switch contacts in high-impact white housing with cord-set strain relief.
5. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
6. Quantity: Three cord sets for every 10 patient beds.

H. Geriatric Call-Button Cord Set:

1. Plug and **72-inch (1800-mm)** white cord.
2. Resistant to medical gas environment equipped with momentary-action, light-pressure switch in soft outer jacket.
3. Ethylene oxide, sterilizable.

4. Washable cord.
5. Palladium switch contacts in high-impact white housing with cord-set strain relief.
6. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
7. Quantity: Two cord sets for every 10 patient beds.

I. Squeeze-Bulb Switch Cord Set:

1. Plug and **72-inch (1800-mm)** washable tube with white cord set.
2. Resistant to medical gas environment; washable; equipped with neoprene squeeze-bulb activator, and plug-mounted, momentary contact switch.
3. Ethylene oxide, sterilizable.
4. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
5. Quantity: Two cord sets for every 10 patient beds.

J. Breath Call Cord:

1. Flexible PVC jacketed cable and a momentary contact air-pressure sensitive switch.
2. Cord: **108 inches (2700 mm)** long.
3. Include an adjustable arm for clamping and suitable for use in oxygen atmospheres.
4. Include 12 replacement straws.

K. Pillow Speakers:

1. Eight-conductor, DIN, flexible PVC jacketed cable.
2. Contain nurse-call button, volume control, speaker, and channel control in molded flame-retardant ABS housing.
3. Cord: **96 inches (2400 mm)** long with sheet clip.

L. Call-Button Plug:

1. Designed to plug into patient station cord-set receptacle.
2. Button switches call circuit.
3. Two plugs for every 10 patient beds.

M. Dummy Plugs:

1. Designed to plug into patient station cord-set receptacle when call-button plug or patient cord set is not used.
2. Three plugs for every 10 patient beds.

N. Indicator Lamps: Digital type with rated life of 20 years unless otherwise indicated.

O. Station Faceplates, Stainless Steel:

1. Minimum of **0.0375 inch (0.95 mm)** thick.
2. Finish: Brushed.
3. Machine-engraved labeling identifies indicator lamps and controls.

P. Station Faceplates, High-Impact Plastic:

1. Color: [**Beige**]<**Insert color**>.
2. Molded or machine-engraved labeling identifies indicator lamps and controls.

Q. Corridor Dome Lights and Zone Lights:

1. Three-lamp signal lights.
2. Lamps: [**LED.**]Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.
3. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.
4. Filters: Two per unit, amber and red.

R. Cable:

1. Conductors: Jacketed single and multiple, twisted-pair copper cables.
2. Sizes and Types: As recommended by equipment manufacturer.
3. Cable for Use in Plenums: Listed and labeled for plenum installation.

S. Grounding Components: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

2.5 SOFTWARE REQUIREMENTS

A. Telephone System Interface:

1. Permits use of wired and/or wireless telephones to execute nurse-call master station.
2. Two-way communication with patient and staff stations.
3. Two-way communication with the master nurse station.
4. "All Call," group call, and staff call paging.
5. Capable of being programmed to forward calls destined for a master nurse station to any connected telephone.
6. Telephones connected to the telephone interface shall have the same call tone ring patterns as those generated at the master nurse station.
7. Telephones having a display shall indicate the call type, priority code, and the calling station number of incoming calls.
8. Telephones shall be capable of initiating a service request for a particular patient station, logging calls on the master station's reminder list, and activating door lock mechanisms associated with a call station.
9. Capable of routine setup and configuration changes using the keypads on display telephone and/or the master station.

B. Display Telephones:

1. Digital telephones for use as mini-master nurse-call stations.
2. Digital display shall indicate the call type, priority code, and calling station number of incoming calls.
3. Ring patterns shall be identical to those generated at the master station.
4. Capable of two-way communication with patient and staff stations and the master station, and other telephones interfaced with the system.
5. Capable of placing or answering outside calls when interfaced with the facility telephone system.
6. Capable of "All Call," group call, and staff call paging and of initiating service requests, logging calls to the reminder list, and activating optional door controls.

C. Third-Party Pocket Pager Interface:

1. Equipped with a standalone pocket pager interface.
2. Connects with the facility paging system and transmit alphanumeric messages to the pocket pagers as preprogrammed in the system.

D. Statistical Software:

1. Includes a data statistical software package that stores, sorts, and analyzes activities occurring on the nurse-call system network.
2. Windows based and operated on a PC that is connected to the nurse-call system network.
3. Stores events on the PC's hard disk. Accumulation of these stored events shall make up the database that is used to generate reports and statistics.
4. Events stored by the software shall include date, day of week, time, ward, priority, and room number.
5. Capable of assigning a patient name to bed number.
6. Stored events shall include, but not be limited to, calls placed, call priority, calls cancelled at the nurse station, calls cancelled at the point of origin, regenerated calls, calls answered, calls sent to pager interface, staff presence registration, staff presence cancellation, service request, service cancellation, and system and network error messages.

E. Data Analysis Software:

1. Capable of analyzing the stored information and generating computed analysis.
2. Analysis of the database can be conducted by specifying one, many, or all of the following parameters of the database: date, day of week, time, wards, priority, and room number.
3. Analysis shall include, but not be limited to, total number of calls placed, average call response time (from call placed to call cancellation), total number of presence registrations, average presence time in a room, total number of service requests, average response time (from audio answer to call cancellation), and average ring time (from call placed to audio answer).

F. Statistical Software Package:

1. Capable of displaying multiple calls/events on a PC monitor or on a RS-485 data-bus-driven digital display panel.
2. Calls from patient or staff stations and associated devices shall be displayed by priority. Display shall be customizable as follows:

    a. Choice of color by type of call.
    b. Choice of display size (character size).
    c. Choice of priority levels, type of events, points of origin.
    d. Identification of facility.
    e. Identification of ward.
    f. Identification of patient with specific patient information.

2.6 CONDUCTORS AND CABLES

A. Audio Cables:

1. Conductors: Jacketed, twisted-pair and twisted-multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Insulation: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.
3. Shielding: For speaker/microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
4. Minimum Shielding Coverage on Conductors: 60 percent.
5. Plenum Cable: Listed and labeled for plenum installation.

B. Data Cable and Hardware: [**Category 5e**][**Category 6**] balanced twisted-pair cabling and hardware. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

C. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in [**Section 260519 "Low-Voltage Electrical Power Conductors and Cables."**][**Section 260523 "Control**

Voltage Electrical Power Conductors and Cables."]

D. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in [**Section 260519 "Low-Voltage Electrical Power Conductors and Cables."**][**Section 260523 "Control Voltage Electrical Power Conductors and Cables."**]

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method:

1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**].

   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Conceal raceway and cables except in unfinished spaces.

2. Cable Trays: Comply with requirements in Section 260536 "Cable Trays for Electrical Systems."
3. Conduit and Boxes: Comply with requirements in Section 270528 "Pathways for Communications Systems."[**Flexible metal conduit shall not be used.**]

   a. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.

B. Install cables without damaging conductors, shield, or jacket.

C. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.

D. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in same raceway.
2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.

E. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, or fittings.

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide **12-inch (300-mm)** minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.

H. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in

junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.

I. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.

J. Identification of Conductors and Cables: Comply with requirements in Section 260553 "Identification for Electrical Systems" for cable administration, cable schedule, and cable and wire identification.

K. Equipment Identification:

1. Comply with requirements in Section 260553 "Identification for Electrical Systems" for equipment labels and signs and labeling installation requirements.
2. Label stations, controls, and indications using approved consistent nomenclature.

3.2 EXISTING SYSTEMS

A. Examine existing systems for proper operation, compatibility with new equipment, and deficiencies. If discrepancies or impairments to successful connection and operation of interconnected equipment are found, report them and do not proceed with installation until directed. Schedule existing systems' examination so there is reasonable time to resolve problems without delaying construction.

3.3 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.

C. Grounding Provisions: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service Assistance: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Schedule tests a minimum of seven days in advance.
2. Report: Submit a written record of test results.
3. Operational Test: Perform an operational system test and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and "All Call" messages and pages at each nurse-call station. Verify proper routing, volume

levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:

a. Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 mPa of sound pressure.
b. Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
c. Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.

4. Test Procedure:

a. Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
b. Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings using the following procedure: Disconnect a speaker/microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.
c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse-call equipment amplifier, and measure the distortion in the amplifier output.

D. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

F. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to [**three**]<**Insert number**> visits to Project during other-than-normal operating hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.

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SECTION 27 53 13 00 - CLOCK SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Master and secondary clock system.
2. Master clock.
3. Secondary indicating clocks.
4. Program signal devices.
5. Clock circuit power booster.
6. Back boxes for secondary indicating clocks and program devices.
7. Guards.
8. Rack-mounting provision for master clock.
9. Conductors and cables.
10. Pathways.

1.2 DEFINITIONS

A. NIST: The National Institute of Science and Technology.

B. PC: Personal computer.

C. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude; a worldwide standard for time synchronization.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Master and secondary clock system.
2. Master clock.
3. Secondary indicating clocks.
4. Program signal devices.
5. Clock circuit power booster.
6. Back boxes for secondary indicating clocks and program devices.
7. Guards.
8. Rack-mounting provision for master clock.
9. Conductors and cables.
10. Pathways.

B. Product Data Submittals: For each product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:

1. Master unit.
2. Indicating clocks.

3. Signal equipment.
4. Equipment enclosures and back boxes.
5. Accessory components.

C. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring and correction circuits.

   a. Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
   b. Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Show protection from overcurrent, static discharge, and voltage surge.

2. Details of seismic restraints including mounting, anchoring, and fastening devices for the following system components:

   a. Surface-mounted and semirecessed secondary indicating clocks.
   b. Master clock [**enclosures**][**mounting racks**].
   c. Clock circuit power boosters.

3. Details of seismic strengthening of master clock [**enclosures**][**mounting racks**].
4. Dimensioned Outline Drawings of the Mounting Rack for the Master Clock: Show internal seismic bracing, and locate center of gravity of fully equipped and assembled unit. Locate and describe mounting and anchorage provisions.

D. Samples for Initial Selection:

1. Manufacturer's color photographs or color chips showing the full range of colors available for clocks, signal equipment, and control panels.
2. Representative operating models of clock type <**Insert designations of clocks for which Samples are required**>.

E. Delegated Design Submittals: For the master clock and housing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of the master clock and housing.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for the master clock, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Master clock and housing shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

2.2 MASTER AND SECONDARY CLOCK SYSTEM

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Time & Signal Co**]
2. [**Dukane Communication Systems**]
3. [**Faraday**]
4. [**Lathem Time**]
5. [**Midwest Time Control, Inc.**]
6. [**National Time & Signal Corporation**]
7. [**Primex, Inc.**]
8. [**Rauland-Borg Corporation**]
9. [**Sapling, Inc.**]
10. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
11. [**Telecor Inc**]
12. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**American Time & Signal Co**]
2. [**Dukane Communication Systems**]
3. [**Faraday**]
4. [**Lathem Time**]
5. [**Midwest Time Control, Inc.**]
6. [**National Time & Signal Corporation**]

7. [**Primex, Inc.**]
8. [**Rauland-Borg Corporation**]
9. [**Sapling, Inc.**]
10. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
11. [**Telecor Inc**]
12. <**Insert manufacturer's name**>

C. System Functions and Features:

1. Supply power to remote indicating clocks[**except those indicated to have correction signals applied through a data circuit**].
2. Maintain correct synchronized time and transmit time-correction signals over dedicated system wiring from a master clock to any [**one**][**two**]<**Insert number**> type(s) of secondary indicating clocks, including the following:

    a. Analog Synchronous Clocks: Correct for minute- and second-hand synchronization at least once each hour and for hour-hand synchronization at least once each day.
    b. Digital Clocks: Test clocks automatically for synchronization with master time control at least once every hour and automatically correct those not synchronized with the time reference unit.[**Automatically correct clocks immediately when power is restored after an outage of power to the master clock.**]

3. Initiate and execute programs for scheduled automatic operation of remote devices. Include [**audible signal devices**][**and**][**visual signal devices**][**and on and off switching of equipment and circuits**].
4. Provide for manual control of programmed signal and equipment-switching circuits.
5. Communicate with remote PC [**for access to UTC time base**][**and**][**to permit programming from remote location**].
6. Maintain system access security with a minimum of [**one level**][**two levels**][**three levels**] of user-access control to restrict use of system controls to authorized personnel.[**Levels of access apply to both local access and access from a remote computer.**] Access to user programming and control functions is accomplished by entering a minimum three-digit code. Access levels include the following:

    a. Access to review existing programs only.
    b. Access to normal system operating controls.
    c. Access to all user-programming and control functions.

7. Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator.
8. Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator, and automated periodic reference to NIST or UTC time signals via [**internal telephone modem and automatic dialup connection**][**internal modem and network or microcomputer Internet access**][**dedicated internal radio receiver tuned to NIST time signal broadcasts**]. Reference time signals shall be automatically accessed at programmable intervals.
9. Provide for programming multiple independent event schedules into memory and running them simultaneously for different output circuits.

    a. Quantity of Programmable Schedules: [**Three**][**Four**][**Eight**][**18**][**250**], minimum.
    b. Number of Weekly Events That Can Be Programmed for Each Schedule: [**64**][**128**][**300**][**600**][**2500**], minimum.
    c. Simultaneous operation of independent schedules shall be limited only by the number of signal-device and equipment-switching output circuits.
    d. Advance Programming for Automatic Holiday Schedule Changes: Number of schedule

changes that can be programmed to suit holidays and vacations shall be [**10**][**16**][**50**][**100**], and each change may be programmed up to a year in advance to occur on any day of the calendar year.

10. Automatically check functioning of LEDs, switches, input keys, central processor, read-only memory, random access memory, and output circuits. A display on the control panel[**or a remote computer with the proper access code**] shall indicate failure by identifying faulty component or circuit and shall recommend corrective action.
11. Provide [**manually initiated**][**programming for automatic**] daylight savings time correction.
12. Provide for adjustments to master clock output signals. Duration of momentary signal shall be individually programmable for each signal and equipment-control output circuit from 1 to 99 seconds. Signals shall be programmable for either on or off switching to suit equipment-operation scheduling.

2.3 MASTER CLOCK

A. Description: Microprocessor-based, software-controlled unit complying with Class A device requirements in 47 CFR 15.

1. Programming and control switches.
2. Informational Display: LED or backlit LCD type.

    a. Normally shows current time[**, date, and day of week**] display.
    b. Provides programming cues when system is being programmed.

3. Output Circuits for Power and Correction of Secondary Indicating Clocks:

    a. Wired Synchronous Clock Power-and-Correction Circuits: For [**analog**][**and**][**digital**] clocks; a minimum of [**one**][**two**]<**Insert number**> required. Relay controlled.
    b. Wired Synchronous Digital Clock Power-and-Correction Circuits: [**One**]<**Insert number**> required.
    c. Existing Clock Power-and-Correction Circuit: An output circuit suitable for <**Insert description of type of existing power-and-correction circuit and number of clocks to be connected**>.

4. Data Output Port for Secondary Clock Correction Circuit: [**Digital,**]RS485 or similar circuit for scheduled periodic correction signals.
5. Modem and PC interface software suitable for [**remote programming**][**and**][**automatic NIST or UTC synchronization**].
6. Circuits for Audible Signal Devices: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, [**five**][**10**] A minimum. A minimum of [**two**][**four**][**six**][**eight**]<**Insert number**> circuits.
7. Circuits for Visual Signal Devices: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, [**five**][**10**] A minimum. A minimum of [**two**][**four**][**six**][**eight**]<**Insert number**> circuits.
8. Circuits for Programmable Switching of Remote Equipment and Circuits: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, [**5**][**10**] A minimum. A minimum of [**two**][**four**][**six**][**eight**]<**Insert number**> circuits.
9. Power Supplies: Capacity for internal loads and power-and correction circuits of connected clocks.
10. Enclosure: Metal cabinet with locking front panel. When cabinet is locked, display indication shall be visible on or through front panel face. Arrange cabinet for surface, semirecessed, or flush mounting as indicated.
11. Housing: Rack-mounting metal enclosure with display indication visible on front panel face.

a. Reinforce mounting and attachment capable of resisting seismic forces described in Section 260548.16 "Seismic Controls for Electrical Systems."

12. Battery Backup for Time Base: Lithium battery to maintain the timekeeping function and retain the programs in memory during outage of normal ac power supply for up to 10 years.
13. Electrostatic Discharge Resistance: Master clock[**and secondary indicating clocks**] shall be tested and certified according to IEC 61000-4-2 in both human-discharge and direct-injection modes.

2.4 SECONDARY INDICATING CLOCKS

A. Analog Clock: Equipped with a sweep second hand. Movement shall be driven by self-starting, permanently lubricated, sealed synchronous motor equipped with a correcting solenoid actuator, or be a microprocessor-based, second impulse unit, compatible with the master clock.

B. Digital Clock: Microprocessor-controlled unit complying with Class A device requirements in 47 CFR 15, with red LED digital time display of hours [**and minutes**][**, minutes, and seconds**].

1. Display Height, 2-1/2-Inch (64-mm) Clock: Hour and minute numerals readable at **50 feet (15 m)**.
2. Display Height, 4-Inch (102-mm) Clock: Hour and minute numerals readable at **100 feet (30 m)**.
3. Display Format: Selectable between 12-hour with "PM" LED display and 24-hour formats.
4. Connections for Power and Correction:

a. Wired synchronous connection to the master clock for both operating power and correction.

1) Time-Base Backup, Internal Alkaline Battery: Backs up internal time base to maintain timekeeping during power outages of up to six days' duration.
2) Time-Base Backup, Internal Capacitor: Back up internal time base to maintain timekeeping during power outages of up to 12 hours' duration.

b. Correction by RS485, Ethernet, or similar data line with operating power supplied over a separate connection.
c. Power Connection for Secondary Indicating Clocks: [**Plug connector**][**Wire pigtail or compression splice**].

C. Interval-Timer Clock: Digital microprocessor-controlled, **4-inch (102-mm)** unit with **2-1/2-inch (64-mm)**, red LED digital display for hours and minutes and **1-5/16-inch (33-mm)** display for seconds; a separately mounted, mode-control switch; and the following features:

1. Display Visibility: Hour and minute numerals readable at [**30 feet (10 m)**]<**Insert dimension**> in normal ambient light.
2. Operating Modes:

a. Normal: Clock operates as a regular secondary system clock, displaying corrected time in normal display configuration, selectable between 12- and 24-hour formats, with "PM" digital display for 12-hour format.
b. Count-Down or Count-Up Timer: Selected by mode-control switch count-up and count-down positions, and capable of being preset at the mode-control station.
c. Code Blue: Automatically selected by a signal through a wiring connection from [**the code-blue system**]<**Insert source for the initiating signal**>. This signal captures control of the clock regardless of current mode or correction status and instantly initiates count-up operation, starting at time 00:00:00. While in this mode, other clock functions, including correction, shall run in the background. Clock shall revert to normal operating mode when

the initiating-signal system is reset.

3. Mode-Selector Switch: Push-button or rotary, multiposition type, flush mounted; with start, stop, and reset capability in both count-up and count-down modes.
4. Audible tone signal: Housed in clock or mode-selector-switch box. Sounds at end of preset up or down count.

D. Provision for Modular Panel Installation: Equip designated clock for panel mounting. Mount flush or semirecessed with arrangement and trim as indicated. Coordinate wiring with other modular panel components, including [**room lighting switches**][**intercom devices**][**convenience outlets**][**data outlets**][**speaker**] and other similar devices.

E. Provision for Time-Tone-Unit Installation: Equip indicated clocks for housing or mounting in an acoustically treated and baffled speaker compartment specified in Section 275116 "Public Address and Mass Notification Systems."

F. Secondary Indicating Clock Characteristics:

1. Clock Type: [**Analog**][**Digital**].
2. Face Configuration: [**Single**][**Double**].
3. Mounting: [**Recessed**][**Semirecessed**][**Pendant**][**Surface**][**Suspended**][**Within time-tone unit**][**Within modular panel**]<**Insert mounting height of pendant, wall, and suspended clocks**>.
4. Nominal Dimensions: <**Insert depth and nominal diameter or height and width in inches (mm)**>.
5. Casing Finish: <**Insert description, including types and colors**>.
6. Special Environmental Conditions: <**Describe conditions such as corrosive, damp, or wet locations**>.
7. Dial Face Color: <**Insert color**>.
8. Analog Clock Crystal: Clear [**glass**][**acrylic**][**polycarbonate**].
9. Face Color: <**Insert color**>.
10. Display Height: <**Insert inches (mm)**>.
11. Seconds Display: [**Yes**][**No**].
12. Digital Clock Lens: Antiglare acrylic material.
13. Battery Backup: [**Yes**][**No**].
14. Interval-Timer Display: [**Yes**][**No**].

2.5 PROGRAM SIGNAL DEVICES

A. Bells: Heavy-duty, modular, vibrating type with the following sound-output ratings measured at **10 feet (3 m)**:

1. 4-Inch (100-mm) Bell: 90 dB.
2. 6-Inch (150-mm) Bell: 95 dB.
3. 10-Inch (250-mm) Bell: 104 dB.

B. Chimes: Heavy-duty, modular, vibrating chimes with polished-chrome tone bar and enamel-finished housing. Minimum sound-output rating measured at **10 feet (3 m)** shall be 75 dB.

C. Clock Buzzers: Adjustable output signal device designed for mounting within clock housing or outlet box.

1. Sound-Output Rating Measured at 3 Feet (1 m): 75 dB.
2. Audible Tone Frequency: Manufacturer's standard between 120 Hz and 2 kHz.

D. Horns: Modular, adjustable-output, vibrating type with minimum full-intensity-rated sound output of 103 dB measured at **10 feet (3 m)**.

E. Projector Horns: Adjustable-output, vibrating type with [**single**][**double**] projector arranged to channel sound in the direction of the projector axis, and with minimum full-intensity-rated sound output of 104 dB measured at **10 feet (3 m)**.

F. Loudspeakers for Audible Tones: See Section 275116 "Public Address and Mass Notification Systems."

G. Visible Signal Devices: Strobe lights with [**blue**][**yellow**] polycarbonate lens and xenon flash tube, with lens mounted on an aluminum faceplate and the word "Program" engraved in letters at least **1 inch (25 mm)** high on lens. Lamp unit shall have a minimum rated light output of 75 candela.

H. Combination Audible and Visible Signal Devices: Factory-integrated horn and strobe light in a single mounting assembly.

I. Outdoor Signal Equipment: Weatherproof models listed for outdoor use.

J. Mounting Arrangement for Signal Devices: Designed for attachment with screws on the mounting plate of a flush-mounted back box unless otherwise indicated.

K. Enclosures for Flush-Mounting Bells and Horns: Enclosure, mounting plate, and grille assembly shall be furnished by device manufacturer to match features of the device to be mounted. Enclosure shall be recessed in wall, completely enclosing the device, with grille mounting over the open side of the enclosure and flush with the wall.

L. Connection Provision for Signal-Indicating Devices: [**Plug connector**][**Wire pigtail or compression splice**].

2.6 CLOCK CIRCUIT POWER BOOSTER

A. Description: Transformer power supply, mounted in steel cabinet with hinged door, and having fuse-protected input and output circuits.

2.7 BACK BOXES FOR SECONDARY INDICATING CLOCKS AND PROGRAM DEVICES

A. Description: Box and cover-plate assembly shall be furnished by device manufacturer and be suitable for device to be mounted. Back boxes shall be equipped with knockouts and hanger straps or mounting adapters arranged for flush mounting the device unless otherwise indicated.

2.8 GUARDS

A. Description: Formed-steel wire, shaped to fit around guarded device, with **1-inch (25-mm)** maximum clearance.

1. Mounting Provisions: Fixed tabs, welded to guard and arranged for screw attachment to mounting surface.
2. Finish for Indoor Devices: [**Clear**]<**Insert finish color**> epoxy lacquer over zinc plating.
3. Finish for Outdoor Devices: [**Black**]<**Insert finish color**> powder coat over zinc plating and primer.

2.9 RACK-MOUNTING PROVISION FOR MASTER CLOCK

A. Equipment Cabinet: [**Floor**][**Wall**]-mounted, rack type. Comply with EIA-310-D and the following:

1. Cabinet Housing: Constructed of steel, with front[**and rear**] doors; with manufacturer's standard tumbler locks, keyed alike.

    a. Front door shall have a clear panel in front of the master clock display.
    b. Housing shall enclose master clock and auxiliary clock system components, plus a minimum of [**20**]<**Insert number**> percent spare capacity for future equipment.

2. Forced Ventilation: Internal low-noise fan with a filtered intake vent, connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switchable and arranged to be powered when main cabinet power switch is on.
3. Natural Ventilation: Ventilated rear and sides with louvers and solid top.
4. Arrange inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
5. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by equipment or panels.
6. Finish: Uniform, baked-enamel, [**manufacturer's standard color**]<**Insert color**> finish over rust-inhibiting primer.
7. Power-Control Panel: On front of equipment housing; with master power on-off switch and pilot light, and socket for a 5-A, indicating, cartridge fuse for rack equipment power.
8. Vertical Plug Strip: Grounded receptacles, **12 inches (300 mm)** o.c. the full height of rack, to supply rack-mounting equipment.
9. Maintenance Receptacles: Duplex convenience outlet with supply terminals separate from equipment plug strip and located in front of rack.

2.10 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG. Voltage drop for signal, control, and clock correction circuits shall not exceed 10 percent under peak load conditions.

B. 120-V AC and Class 1 Signal and Control Circuits: Stranded, single conductors of size and type recommended by system manufacturer. Materials and installation requirements are specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 2 and Class 3 Signal and Control Circuits: Single conductor or twisted-pair cable, unshielded, unless manufacturer recommends shielded cable. Materials and installation requirements are specified in Section 260523 "Control-Voltage Electrical Power Conductors and Cables."

D. Data Circuits: Category 6 minimum, unshielded, twisted-pair cable, unless manufacturer recommends shielded cable.

E. Insulation: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.

F. Plenum Cable: Listed and labeled for plenum installation.

G. Conductor Color-Coding: Uniformly identified and coordinated with wiring diagrams.

H. Shielding: For speaker-microphone leads and at other locations recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.

1. Minimum Shielding Coverage on Conductors: 60 percent.

2.11 PATHWAYS

A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Section 270528 "Pathways for Communications Systems."

1. Raceway Type: [**Optical fiber/communications raceway and fittings**][**Metal wireways**][**Nonmetal wireways**][**Surface metal raceways**][**Surface nonmetal raceways**].

B. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.

C. Flexible metal conduit is prohibited.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Section 260548.16 "Seismic Controls for Electrical Systems."

3.2 WIRING METHODS

A. Wiring in Raceways and Trays: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring in Ceilings, Walls, and Floors: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Support cables not enclosed in raceways on J-Hooks. Install, size, and space J-Hooks to comply with TIA-568-C.

3.3 ELECTRICAL CONNECTIONS

A. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

B. Use [**plug connectors**][**splices**] for connections to clocks and signal devices.

C. Ground clocks, programming equipment, and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.4 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service Assistance: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
2. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

D. Clock system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Program system according to Owner's requirements. Set system so signal devices operate on Owner-required schedules and are activated for durations selected by Owner. Program equipment-control output circuits to suit Owner's operating schedule for equipment controlled.

B. Adjust sound-output level of adjustable signal devices to suit Owner's requirements.

C. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

END OF SECTION 27 53 13 00

Task	Specification	Specification Description
27 53 13 13	27 53 13 00	Clock Systems
27 53 13 16	27 53 13 00	Clock Systems

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Task	Specification	Specification Description
28 00 00 00	28 10 00 00a	Access Control Software and Database Management
28 05 00 00	28 10 00 00a	Access Control Software and Database Management
28 05 26 00	28 10 00 00a	Access Control Software and Database Management
28 05 53 00	28 10 00 00a	Access Control Software and Database Management

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SECTION 28 10 00 00 - ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Access control system.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**]<**Insert Section number and title**> specifies preinstallation conference procedures.
5. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**] specifies the following:

    a. Electric strike(s).
    b. Electromagnetic lock(s).
    c. Delayed-egress electromagnetic lock(s).
    d. Electromechanical lock(s).
    e. Self-contained electronic lock(s).
    f. Exit lock(s) and alarm(s).
    g. Auxiliary electrified door hardware.

6. Section 087113 "Power Door Operators" specifies the following:

    a. Door operator controls.
    b. Panic exit device(s).
    c. Electric strike(s).
    d. Auxiliary electrified door hardware.

7. Section 281300 "Access Control Software and Database Management" specifies the following:

    a. Access control system unit operating system software.
    b. Access control system unit antivirus and security protection software.
    c. Visitor management database software.
    d. Mobile credential validation database software.
    e. Access control system supplementary computer equipment operating system software.
    f. Access control system supplementary computer equipment antivirus and security protection software.
    g. Credential card personalization software.
    h. Credential card printer and encoder software.

8. Section 281400 "Access Control System Hardware" specifies the following:

a. Access control system server(s).
b. Access control system DGP(s).
c. Access control system door controller(s).
d. Access control system input/output interface(s).
e. Access control system power supply and battery charger(s).
f. Access control system [**terminal(s)**][**workstation(s)**].
g. Access control system printer(s) and encoder(s).

9. Section 281500 "Integrated Access Control Hardware Devices" specifies the following:

a. Swipe card reader(s).
b. Proximity reader(s) for card, fob, or smartphone.
c. Door lock keypad(s).
d. Scramble keypad(s).
e. Combination card reader(s) and keypad(s).
f. Access control cards.
g. Electrically controlled single-point latch(es).
h. Electrically controlled three-point latch(es).
i. Type 1 high-security electronic lock(s).
j. Type 1F high-security combination lock(s).
k. REX motion sensor(s).
l. REX push-button(s).
m. Magnetic lock hardware with special locking arrangement for fire-rated door(s).
n. Panic hardware with special locking arrangement for fire-rated door(s).
o. NFC access control device(s).
p. Electronic key management system unit(s).

10. Section 281511 "Integrated Credential Readers and Entry Management" specifies the following:

a. Swipe card reader(s).
b. Chip card reader(s).
c. Proximity reader(s) for card, fob, or smartphone.
d. Proximity card reader(s) for hazardous (classified) location.
e. Door lock keypad(s).
f. LCD alarm keypad(s).
g. Scramble keypad(s).
h. Single finger scanner(s).
i. Palm scanner(s).
j. Iris scanner(s).
k. Facial scanner(s).
l. Combination card reader(s) and keypad(s).
m. Combination card reader(s)/keypad(s) and biometrics scanner(s).

11. Section 281513 "Access Control Credentials" specifies the following:

a. Access control cards.
b. Wireless key fobs.

12. Section 281515 "Electrified Locking Devices and Accessories" specifies the following:

a. Electrically controlled single-point latch(es).
b. Electrically controlled two-point latch(es).
c. Electrically controlled three-point latch(es).
d. Type 1 high-security electronic lock(s).
e. Type 1F high-security combination lock(s).

f. Type 2 high-security combination lock(s).
g. REX motion sensor(s).
h. REX push-button(s).

13. Section 281517 "Egress Management Devices" specifies the following:

a. Magnetic lock hardware with special locking arrangement.
b. Panic hardware with special locking arrangement.

14. Section 281519 "Access Control Remote Devices" specifies the following:

a. NFC access control device(s).
b. Bluetooth communications access control device(s).
c. Wireless communications access control device(s).

15. Section 281521 "Telephone Entry Systems" specifies the following:

a. Analog audio telephone entry system(s).
b. Digital audio-video telephone entry system(s).

16. Section 281523 "Intercom Entry Systems" specifies the following:

a. Digital audio intercom entry system(s).
b. Digital audio-video intercom entry system(s).

17. Section 281525 "Electronic Key Management Systems" specifies the following:

a. Electronic key management system unit(s).
b. Mechanical key management system unit(s).

18. Section 281527 "Access Control Electronic Turnstiles and Mobility Systems" specifies turnstile operator(s) with access control devices.

1.2 DEFINITIONS

A. DGP: Data gathering panel.

B. NFC: Near field communications.

C. REX: Request-to-exit.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

B. Preinstallation Coordination Meeting(s): For access control. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Shop Drawings:

1. Project general notes.
2. Head-end hardware, equipment, and device locations.
3. Block diagram and cable/conduit routing illustrating end-to-end system wiring.
4. End-to-end system communications details.
5. Secondary power calculations
6. <**Insert requirements**>.

B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation and programming instructions for operating system software, including all applicable software add-ons.
2. Installation and programming instructions for antivirus and security protection software.
3. Manufacturer's recommended setup and testing procedure for operating system software and applicable software add-ons.
4. Troubleshooting instructions for operating system software and applicable software add-ons.
5. Manufacturer's recommended setup and testing procedure for antivirus and security protection software.
6. Troubleshooting instructions for antivirus and security protection software.
7. Installation instructions for access control system servers.
8. Installation instructions for access control system DGPs.
9. Installation instructions for access control system input/output interface.
10. Installation instructions for access control system door controllers.
11. Installation instructions for access control system workstation.
12. Installation instructions for access control system power supplies and battery chargers.
13. Installation instructions for access control system printers.
14. Manufacturer's recommended testing and inspection procedure for operation of access control system servers, panels, input/output interfaces, door controllers, and workstations.
15. Manufacturer's recommended testing and inspection procedure for operation of access control system power supplies and battery chargers.
16. Manufacturer's recommended testing and inspection procedure for operation of access control system printers.
17. Installation instructions for integrated credential readers and entry management devices.
18. Printing, programming, and handling instructions for access control credentials.
19. Installation instructions for electrified locking devices and accessories.
20. Installation instructions for egress management devices.
21. Installation instructions for access control remote devices.
22. Installation instructions for telephone entry systems.
23. Installation instructions for intercom entry systems.
24. Installation instructions for electronic key management systems.
25. Installation instructions for access control electronic turnstiles and mobility systems.

26. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
27. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
28. Manufacturer's recommended tests and inspections for egress management devices.
29. Manufacturer's recommended tests and inspections for access control remote devices.
30. Manufacturer's recommended tests and inspections for telephone entry systems.
31. Manufacturer's recommended tests and inspections for intercom entry systems.
32. Manufacturer's recommended tests and inspections for electronic key management systems.
33. Manufacturer's recommended tests and inspections for access control electronic turnstiles and mobility systems.
34. Manufacturer's recommended testing and inspection procedure for end-to-end operation of access control system software, hardware, and integrated hardware devices.

B. Warranty documentation.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for access control system requiring approval by authorities having jurisdiction must be signed and sealed by qualified life safety professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

B. Submittals for access control system require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.8 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.9 WARRANTY FOR ACCESS CONTROL SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed access control system performs in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of access control system perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of

Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for components[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

1.10 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within warranted cycle life.

1. Initial Extended-Warranty Period for Li-ion Batteries: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
2. Follow-On Extended-Warranty Period for Li-ion Batteries: [**Ten**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM

A. Description: Access control system provides a means of regulating or controlling physical entry into an area, or access to or use of a device by electrical, electronic, and/or mechanical means. Typical access control system includes a card reader at a controlled door, which reads a user credential and sends the collected data to a centrally located DGP over the cabling infrastructure. DGP may hold a user database onboard or may communicate with a user database over the network. If user is authorized for access at a controlled door, DGP signals the electronic lock at the door to unlock. If user credential is not authorized according to user database, the door remains locked and access is denied. In addition to card readers and electronic locks, access control systems may include various other connected devices programmed for a desired function.

B. Performance Criteria:

1. Regulatory Requirements:

a. Components listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.
c. Certification: Provide certificate, authorized under UL Certification Service, that access control system installation complies with installation requirements of UL CCN ALOV.

2. Listing Criteria: UL CCN ALOV and UL CCN ALVY; including UL 294.
3. Consult Architect for resolution of conflicting requirements.

C. Selection of Access Control System Components:

1. Source Limitations: Obtain components for access control system from sources approved by [**manufacturer**][**fabricator**][**Installer**] warranting performance of entire system.
2. Provide the following specified products with the access control system:

a. Access Control Software and Database Management:

1) Access control system unit operating system software.
2) Access control system unit antivirus and security protection software.
3) Visitor management database software.
4) Mobile credential validation database software.
5) Access control system supplementary computer equipment operating system software.
6) Access control system supplementary computer equipment antivirus and security protection software.
7) Credential card personalization software.
8) Credential card printer and encoder software.

b. Access Control System Hardware:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system server(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system DGP(s) <**Insert drawing designation**>.
3) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system door controller(s) <**Insert drawing designation**>.
4) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system input/output interface(s) <**Insert drawing designation**>.
5) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system power supply and battery charger(s) <**Insert drawing designation**>.
6) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system [**terminal(s)**][**workstation(s)**]<**Insert drawing designation**>.
7) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> access control system printer(s) and encoder(s) <**Insert drawing designation**>.

c. Security Door Hardware:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electric strike(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electromagnetic lock(s) <**Insert drawing designation**>.
3) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> delayed-egress electromagnetic lock(s) <**Insert drawing designation**>.
4) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electromechanical lock(s) <**Insert drawing designation**>.
5) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> self-contained electronic lock(s) <**Insert drawing designation**>.
6) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> exit lock(s) and alarm(s) <**Insert drawing designation**>.
7) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> auxiliary electrified door hardware <**Insert drawing designation**>.
8) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> door operator controls <**Insert drawing designation**>.
9) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> panic exit device(s) with electric strike <**Insert drawing designation**>.

d. Integrated Credential Readers and Entry Management:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> swipe card reader(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> chip card reader(s)

<**Insert drawing designation**>.

3) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> proximity reader(s) for card, fob, or smartphone <**Insert drawing designation**>.
4) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> proximity card reader(s) for hazardous (classified) location <**Insert drawing designation**>.
5) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> door lock keypad(s) <**Insert drawing designation**>.
6) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> LCD alarm keypad(s) <**Insert drawing designation**>.
7) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> scramble keypad(s) <**Insert drawing designation**>.
8) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> single finger scanner(s) <**Insert drawing designation**>.
9) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> palm scanner(s) <**Insert drawing designation**>.
10) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> iris scanner(s) <**Insert drawing designation**>.
11) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> facial scanner(s) <**Insert drawing designation**>.
12) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> combination card reader(s) and keypad(s) <**Insert drawing designation**>.
13) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> combination card reader(s)/keypad(s) and biometrics scanner(s) <**Insert drawing designation**>.

e. Access Control Credentials:

1) [**Quantity as indicated on Drawings of**][**25**][**50**][**100**]<**Insert quantity**> access control cards <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**25**][**50**][**100**]<**Insert quantity**> wireless key fobs <**Insert drawing designation**>.

f. Electrified Locking Devices and Accessories:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electrically controlled single-point latch(es) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electrically controlled two-point latch(es) <**Insert drawing designation**>.
3) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electrically controlled three-point latch(es) <**Insert drawing designation**>.
4) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> Type 1 high-security electronic lock(s) <**Insert drawing designation**>.
5) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> Type 1F high-security combination lock(s) <**Insert drawing designation**>.
6) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> Type 2 high-security combination lock(s) <**Insert drawing designation**>.
7) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> REX motion sensor(s) <**Insert drawing designation**>.
8) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> REX push-button(s) <**Insert drawing designation**>.

g. Egress Management Devices:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> magnetic lock hardware with special locking arrangement <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> panic hardware

with special locking arrangement <**Insert drawing designation**>.

h. Access Control Remote Devices:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> NFC access control device(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> Bluetooth communications access control device(s) <**Insert drawing designation**>.
3) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> wireless communications access control device(s) <**Insert drawing designation**>.

i. Telephone Entry Systems:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> analog audio telephone entry system(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> digital audio-video telephone entry system(s) <**Insert drawing designation**>.

j. Intercom Entry Systems:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> digital audio intercom entry system(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> digital audio-video intercom entry system(s) <**Insert drawing designation**>.

k. Electronic Key Management Systems:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> electronic key management system unit(s) <**Insert drawing designation**>.
2) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> mechanical key management system unit(s) <**Insert drawing designation**>.

l. Access Control Electronic Turnstiles and Mobility Systems:

1) [**Quantity as indicated on Drawings of**][**One**]<**Insert quantity**> turnstile operator(s) with access control devices <**Insert drawing designation**>.

3. Operation:

a. Exchange database information directly with DGPs.
b. <**Insert specific requirements for sending and receiving access control data to and from external database or storage array**>.

D. Special Techniques:

1. Comply with manufacturer's published instructions.
2. Mounting Heights: Mount field devices in accessible locations in accordance with United States Access Board ADA-ABA Accessibility Guidelines standards.
3. Wiring Methods:

a. Backbone Cable Type: [**Single-mode fiber**][**and**][**or**][**multi-mode fiber**][**or**][**copper**]<**Insert cable type**>.
b. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
c. Analog Maximum Cable Length: [**1000 ft**]<**Insert cable length**>.
d. Digital Maximum Cable Length: [**300 ft**][**500 ft**]<**Insert cable length**>.

E. Interfaces with Other Work:

1. Coordinate installation of new access control system components with existing conditions.

   a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**][**applicable Division 08 Sections**] for interfacing access control system devices with door hardware.
3. Coordinate with [**Section 142100 "Electric Traction Elevators"**][**Section 142400 "Hydraulic Elevators"**] for interfacing access control system with elevator controls.
4. Coordinate with [**Section 230923 "Direct Digital Control (DDC) System for HVAC"**][**Section 230993.11 "Sequence of Operations for HVAC DDC"**] for interfacing access control system with temperature controls to turn HVAC system on and off.
5. Coordinate with [**Section 260923 "Lighting Control Devices"**][**Section 260943.16 "Addressable Luminaire Lighting Controls"**][**Section 260943.23 "Relay-Based Lighting Controls"**] for interfacing access control system with lighting controls.
6. Coordinate with Section 284600 "Fire Detection and Alarm" for unlocking secured doors that are in exit ways, with or without delay.
7. Coordinate with Section 284700 "Mass Notification" for unlocking secured doors that are in exit ways, with or without delay.
8. Coordinate with Section 285213 "Detention Monitoring and Control System and Interfaces" for interfacing access control system with detention monitoring and controls.
9. Coordinate with Section 323113 "Chain Link Fences and Gates" for interfacing access control system with fence and gate controls.

F. Systems Integration:

1. Coordinate with [**Section 283100 "Intrusion Detection"**][**Section 283121 "Area and Perimeter Intrusion Detection"**] for integrating access control system with intrusion detection system.
2. Coordinate with Section 282000 "Video Surveillance" for integrating access control system with video surveillance controls.
3. <**Insert requirements for integrating access control system with other systems**>.

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SYSTEM COMPONENTS

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for access control system components.
2. Perform [**industry standard**]<**Insert test**> tests and inspections for power supplies, batteries, and other standby power provisions.
3. Engage factory-authorized service representative to test end-to-end system connection and functionality.
4. Verify monitoring of access control system status and diagnostics information.

E. Nonconforming Work:

1. Access control equipment will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps**>.

3.4 ADJUSTING

A. Control Sensor Adjustments: Adjust control devices to suit actual occupied conditions.

1. For proximity motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.5 PROTECTION

A. After installation, protect access control system components from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Control Sensor Readjustments: When requested within [**12**]<**Insert number**> months from date of Substantial Completion, provide on-site assistance in readjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 28 10 00 00

SECTION 28 10 00 00A - ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Software for access control system units.
2. Software for access control system supplementary computer equipment.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281400 "Access Control System Hardware" for hardware required to run software specified in this Section.
5. Section 281500 "Integrated Access Control Hardware Devices" for access control field devices controlled by software specified in this Section.

1.2 DEFINITIONS

A. RAM: Random-access memory.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Certificates:

1. <**Insert certificate requirement**>.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and**][**testing**][**and**][**troubleshooting**] instructions issued to Installer by manufacturer for the following:

1. Installation and programming instructions for operating system software, including all applicable

software add-ons.
2. Manufacturer's recommended setup and testing procedure for operating system software and applicable software add-ons.
3. Troubleshooting instructions for operating system software and applicable software add-ons.
4. Installation and programming instructions for antivirus and security protection software.
5. Manufacturer's recommended setup and testing procedure for antivirus and security protection software.
6. Troubleshooting instructions for antivirus and security protection software.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

1.6 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

PART 2 - PRODUCTS

2.1 SOFTWARE FOR ACCESS CONTROL SYSTEM UNITS

A. Description: This category covers software products intended for installation on access control system units.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.
c. <**Insert requirements**>.

2. Listing Criteria:

a. Cybersecurity: UL CCN CYBR; including UL 2900-1 and UL 2900-2-3.
b. Access Control System Functionality: UL CCN ALVY; including UL 294.
c. Hardware that Interfaces with Fire Alarm or Mass Notification: UL CCN UOJK; including UL

864.

C. Access Control System Unit Operating System Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cansec Systems Ltd.**]
   b. [**HID Global; ASSA ABLOY**]
   c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
   d. [**LenelS2; Carrier Global Corporation**]
   e. [**Tyco Software House; Tyco International, Ltd.**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cansec Systems Ltd.**]
   b. [**HID Global; ASSA ABLOY**]
   c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
   d. [**LenelS2; Carrier Global Corporation**]
   e. [**Tyco Software House; Tyco International, Ltd.**]
   f. <**Insert manufacturer's name**>

3. Additional Characteristics:

   a. Provides event logging, notification, and escalation.
   b. Provides threat-level management and response actions.
   c. Provides dashboard view of system health and status.
   d. Maintains credential-driven user records and access history.
   e. Supports network-connected credential readers and controlled doors.
   f. Supports add-on software.
   g. Supports video-surveillance system integration.
   h. Provides email[**and text message**] alerts.
   i. <**Insert characteristics**>.

4. Options:

   a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
   b. User Interface: [**Web browser**][**and**][**mobile app**].
   c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
   d. Drive Space: [**32 GB**][**100 GB**][**500 GB**]<**Insert size**>.
   e. Memory: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**> RAM.
   f. Screen Resolution: [**1280×720**][**1920×1080**]<**Insert resolution**>.
   g. Number of Cardholders: Up to [**1000**][**10,000**][**50,000**][**150,000**]<**Insert number**>.
   h. Number of Supported Readers: Up to [**100**][**500**][**1000**]<**Insert number**>.
   i. Number of Inputs: [**128**][**256**][**1024**]<**Insert number**>.
   j. Number of Outputs: [**128**][**256**][**1024**]<**Insert number**>.
   k. Simultaneous Users: [**Five**][**25**][**35**]<**Insert number**>.

D. Access Control System Unit Antivirus and Security Protection Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Avast Software s.r.o.**]
    b. [**McAfee, LLC**]
    c. [**Microsoft Corporation**]
    d. [**S.C. Bitdefender S.R.L.**]
    e. [**Sophos Ltd.; Sophos Group plc**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Avast Software s.r.o.**]
    b. [**McAfee, LLC**]
    c. [**Microsoft Corporation**]
    d. [**S.C. Bitdefender S.R.L.**]
    e. [**Sophos Ltd.; Sophos Group plc**]
    f. <**Insert manufacturer's name**>

3. Additional Characteristics:

    a. Endpoint detection and response.
    b. Anti-ransomware.
    c. Managed threat response.
    d. Exploit prevention.
    e. Active adversary mitigations.
    f. Email alerts.
    g. <**Insert characteristics**>.

4. Options:

    a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
    b. User Interface: [**Web browser**][**and**][**mobile app**].
    c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
    d. Drive Space: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**>.
    e. Memory: [**1 MB**][**100 MB**][**1 GB**]<**Insert size**> RAM.

E. Visitor Management Database Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**BluBØX Security, Inc.**]
    b. [**HID Global; ASSA ABLOY**]
    c. [**Splan Inc.**]
    d. [**Traction Guest**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**BluBØX Security, Inc.**]
    b. [**HID Global; ASSA ABLOY**]
    c. [**Splan Inc.**]
    d. [**Traction Guest**]
    e. <**Insert manufacturer's name**>

3. Additional Characteristics:

    a. Visitor registration.
    b. Visitor audit trails and reporting.
    c. Badge printing.
    d. Unassisted visitor registration and badging.
    e. Preconfigured security levels of users.
    f. Filters out unsolicited visitors.
    g. Supports integrated credential readers.
    h. <**Insert characteristics**>.

4. Options:

    a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
    b. User Interface: [**Web browser**][**and**][**mobile app**].
    c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
    d. Drive Space: [**100 MB**][**500 MB**][**1 GB**]<**Insert size**>.
    e. Memory: [**500 MB**][**1 GB**][**4 GB**]<**Insert size**> RAM.
    f. Automated Alerts:

        1) Visitor check-in.
        2) Package check-in.
        3) Watch list alert.
        4) Expired badges.
        5) Panic message.
        6) Current visitor.
        7) Maximum visitor.
        8) Frequent visitor.
        9) Time based.

F. Mobile Credential Validation Database Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**HID Global; ASSA ABLOY**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**HID Global; ASSA ABLOY**]

b. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Mobile Validator and Mobile Registration engines.
b. Network-based functionality and database synchronization.
c. Credential audit trail exporting.
d. Contact or contactless verification.
e. Integrated card reader.
f. Biometric finger scanner.
g. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows CE 5.0**][**Windows Mobile 6**]<**Insert operating system**>.
b. Multi-Factor Authentication: [**One**][**Two**][**Three**] factor authentication.
c. Drive Space: [**100 MB**][**500 MB**][**1 GB**]<**Insert size**>.
d. Memory: [**32 MB**][**100 MB**][**1 GB**]<**Insert size**> RAM.
e. Credentials:

1) PIV.
2) PIV-1.
3) TWIC.
4) FRAC.
5) CAC.
6) CIV.
7) Prox.
8) DESFire.

2.2 SOFTWARE FOR ACCESS CONTROL SYSTEM SUPPLEMENTARY COMPUTER EQUIPMENT

A. Description: This category covers software products for installation on access control system supplementary computer equipment that do not inhibit safety or intended operation of access control system hardware devices when they are shut off, lose power, or otherwise fail.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. <**Insert requirements**>.

2. Listing Criteria:

a. Cybersecurity: UL CCN CYBR; including UL 2900-1 and UL 2900-2-3.

C. Access Control System Supplementary Computer Equipment Operating System Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**LenelS2; Carrier Global Corporation**]
e. [**Tyco Software House; Tyco International, Ltd.**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**LenelS2; Carrier Global Corporation**]
e. [**Tyco Software House; Tyco International, Ltd.**]
f. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Provides event logging, notification, and escalation.
b. Provides threat-level management and response actions.
c. Provides dashboard view of system health and status.
d. Maintains credential-driven user records and access history.
e. Supports network-connected credential readers and controlled doors.
f. Supports add-on software.
g. Supports video-surveillance system integration.
h. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
b. User Interface: [**Web browser**][**and**][**mobile app**].
c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
d. Drive Space: [**32 GB**][**100 GB**][**500 GB**]<**Insert size**>.
e. Memory: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**> RAM.
f. Screen Resolution: [**1280×720**][**1920×1080**]<**Insert resolution**>.
g. Number of Cardholders: Up to [**1000**][**10,000**][**50,000**][**150,000**]<**Insert number**>.
h. Number of Supported Readers: Up to [**100**][**500**][**1000**]<**Insert number**>.
i. Number of Inputs: [**128**][**256**][**1024**]<**Insert number**>.
j. Number of Outputs: [**128**][**256**][**1024**]<**Insert number**>.
k. Simultaneous Users: [**Five**][**25**][**35**]<**Insert number**>.

D. Access Control System Supplementary Computer Equipment Antivirus and Security Protection Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Avast Software s.r.o.**]
b. [**McAfee, LLC**]
c. [**Microsoft Corporation**]
d. [**S.C. Bitdefender S.R.L.**]

e. [**Sophos Ltd.; Sophos Group plc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Avast Software s.r.o.**]
b. [**McAfee, LLC**]
c. [**Microsoft Corporation**]
d. [**S.C. Bitdefender S.R.L.**]
e. [**Sophos Ltd.; Sophos Group plc**]
f. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Endpoint detection and response.
b. Anti-ransomware.
c. Managed threat response.
d. Exploit prevention.
e. Active adversary mitigations.
f. Email alerts.
g. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
b. User Interface: [**Web browser**][**and**][**mobile app**].
c. Web Browser: [**Microsoft Internet Explorer**][**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
d. Drive Space: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**>.
e. Memory: [**1 MB**][**100 MB**][**1 GB**]<**Insert size**> RAM.

E. Credential Card Personalization Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CardLogix Corporation**]
b. [**HID Global; ASSA ABLOY**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CardLogix Corporation**]
b. [**HID Global; ASSA ABLOY**]
c. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Credential card design and data-entry customization.

b. Card data fields populated directly from internal or networked database.
c. User-defined privileges.
d. Quick filter for searching internal database.
e. Global find for searching all networked databases.
f. Customized reporting.
g. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
b. User Interface: [**Web browser**][**and**][**mobile app**].
c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web browser**>.
d. Drive Space: [**1 GB**][**5 GB**][**10 GB**]<**Insert size**>.
e. Memory: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**> RAM.

F. Credential Card Printer and Encoder Software:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CardLogix Corporation**]
b. [**HID Global; ASSA ABLOY**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**CardLogix Corporation**]
b. [**HID Global; ASSA ABLOY**]
c. <**Insert manufacturer's name**>

3. Additional Characteristics:

a. Printer status and diagnostics information.
b. Diagnostics information.
c. Printer integration enables control of printing and encoding through software APIs.
d. Integrates with credential management systems through standard application programming interfaces (APIs).
e. Supports Standard Development Languages:

1) Microsoft Visual Basic.NET.
2) Visual C++.
3) Visual C#.
4) Oracle Java.

f. <**Insert characteristics**>.

4. Options:

a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system**>.
b. User Interface: [**Web browser**][**and**][**mobile app**].
c. Web Browser: [**Microsoft Edge (Chromium)**][**or**][**Google Chrome**]<**Insert web**

browser>.
d. Drive Space: [**1 GB**][**5 GB**][**10 GB**]<**Insert size**>.
e. Memory: [**1 GB**][**4 GB**][**8 GB**]<**Insert size**> RAM.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SOFTWARE

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Installation of Access Control Software: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with requirements in guide information for UL CCN ALVY, UL CCN CYBR, and UL CCN UOJK.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Coordinate installation of new access control software with existing equipment and network conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Section 281000 "Access Control" for physical and functional interfaces with access control system and for compliance with system-wide performance requirements.
3. Coordinate with Section 281400 "Access Control System Hardware" for products that require access control software specified in this Section for operation and compliance with system-wide performance requirements.
4. Coordinate with Section 284600 "Fire Detection and Alarm" for interfacing access control system inputs/outputs with fire-alarm system inputs/outputs.

E. Systems Integration:

1. <**Insert requirements for integration with other systems**>.

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SOFTWARE

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Software will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective software and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete software installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps**>.

3.4 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

    a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 10 00 00A

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SECTION 28 10 00 00B - ACCESS CONTROL SYSTEM HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access control system units.
2. Access control system power supplies and battery chargers.
3. Access control system supplementary computer equipment.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281300 "Access Control Software and Database Requirements" for software required to run hardware specified in this Section.
5. Section 281500 "Integrated Access Control Hardware Devices" for access control field devices controlled by hardware specified in this Section.

1.2 DEFINITIONS

A. DGP: Data gathering panel.

B. LAN: Local area network.

C. RAID: Redundant array of inexpensive disks; redundant array of independent disks.

D. RAM: Random-access memory.

E. WAN: Wide area network.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For access control system hardware. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Hardware and equipment locations.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. Hardware and equipment installation details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for access control system servers.
2. Installation instructions for access control system DGPs.
3. Installation instructions for access control system input/output interface.
4. Installation instructions for access control system door controllers.
5. Installation instructions for access control system workstation.
6. Manufacturer's recommended testing and inspection procedure for operation of access control system servers, panels, input/output interfaces, door controllers, and workstations.
7. Installation instructions for access control system power supplies and battery chargers.
8. Manufacturer's recommended testing and inspection procedure for operation of access control system power supplies and battery chargers.
9. Installation instructions for access control system printers.
10. Manufacturer's recommended testing and inspection procedure for operation of access control system printers.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical

testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.8 WARRANTY FOR ACCESS CONTROL SYSTEM HARDWARE

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed access control system hardware perform in accordance with specified requirements and agrees to repair or replace systems, assemblies, components, or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that access control system hardware perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

1.9 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period for Li-ion Batteries: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; full coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
2. Follow-On Extended-Warranty Period for Li-ion Batteries: [**Ten**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
3. Extended-Warranty Period for Ni-MH Batteries: [**Three**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
4. Extended-Warranty Period for Ni-Cd Batteries: [**Five**]<**Insert number**> years from date of Substantial Completion; prorated coverage for materials only, free on board [**origin**][**destination**], freight prepaid.
5. Warranted Cycle Life for Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of **77 deg F (25 deg C)**:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than six discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.

c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

6. Warranted Cycle Life for Premium Valve Regulated (Sealed) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of 77 deg F (25 deg C):

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 40 discharge cycles.
b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 125 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 90 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 750 discharge cycles.

7. Warranted Cycle Life for Flooded (Wet Cell or Open) Lead Acid Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of 77 deg F (25 deg C) and preventive maintenance performed in accordance with manufacturer's published instructions:

a. For discharge rate not faster than eight hours, discharge duration not longer than eight hours, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 40 discharge cycles.
b. For discharge rate not faster than one hour, discharge duration not longer than one hour, and voltage at end of discharge not less than 1.75 V, warranted life must be not fewer than 80 discharge cycles.
c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 2700 discharge cycles.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SYSTEM UNITS

A. Description: This category covers head end units for access control systems, providing a means of regulating or controlling physical entry into an area, or access to or use of device by electrical, electronic, and/or mechanical means. Access control systems are investigated as complete configuration based upon manufacturer's specified system components. Access control systems are intended to comply with applicable life safety access and egress requirements.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria: UL CCN ALVY; including UL 294.

C. Access Control System Server :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cisco Systems, Inc.**]
   b. [**Dell Technologies Inc.**]
   c. [**International Business Machines Corp. (IBM)**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cisco Systems, Inc.**]
   b. [**Dell Technologies Inc.**]
   c. [**International Business Machines Corp. (IBM)**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

   a. Ethernet port for connection to LAN/WAN.
   b. <**Insert characteristics**>.

5. Options:

   a. Input Voltage: [**120 V(ac)**]<**Insert power input**>.
   b. Operating Temperature: [**50 to 82 deg F (10 to 28 deg C)**]<**Insert operating temperature**>.
   c. Server Type: [**IBM**][**Windows**][**Lenovo**]<**Insert make**>.
   d. Server Model: <**Insert model**>.
   e. Server Size: [**One rack-unit (1U)**][**Two rack-units (2U)**]<**Insert size**>.
   f. Drive Space: [**100 GB**][**500 GB**][**1 TB**]<**Insert size**>.
   g. Memory: [**16 GB**][**24 GB**][**32 GB**][**48 GB**]<**Insert size**> RAM.
   h. RAID Level: [**RAID 0**][**RAID 1**]<**Insert level**>.
   i. Mounting: EIA/ECA-310 standard **19 inch (482.6 mm)** [**rack mount**][**cabinet mount**].

6. Operation:

   a. <**Insert server operating requirements**>.

7. Accessories:

   a. DIN rails for mounting.

D. Access Control System DGPs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Honeywell Commercial Security; Honeywell International, Inc.**]

b. [**RS2 Technologies; ACRE, LLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell Commercial Security; Honeywell International, Inc.**]
b. [**RS2 Technologies; ACRE, LLC**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Data ports for connection to LAN and downstream DGPs.
b. Integral terminal blocks secured to enclosure.
c. Enclosure lock with tamper switch and monitoring.
d. <**Insert characteristics**>.

5. Options:

a. Input Voltage: [**120 V(ac)**]<**Insert power input**>.
b. Internal Power Supply: [**16.5 V(ac) transformer**][**24 V(dc) power supply**]<**Insert power supply**>.
c. Operating Temperature: [**32 to 120 deg F (0 to 49 deg C)**]<**Insert temperature**>.
d. Enclosure Size: <**Insert size**>.
e. Materials: [**Steel**]<**Insert material**>.
f. Finishes: <**Insert finish**>.
g. Battery Backup: [**12 V**][**24 V**]<**Insert battery type**>.
h. DGP Communication: [**Ethernet**][**TIA-485**]<**Insert type**>.
i. Mounting: [**Wall mount**][**EIA/ECA-310 standard 19 inch (482.6 mm)**][**Rack mount**][**Cabinet mount**].

6. Operation:

a. <**Insert panel operating requirements**>.

7. Accessories:

a. <**Insert accessory**>.

E. Access Control System Door Controllers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HID Global; ASSA ABLOY**]
b. [**IDTECK Global, Inc.**]
c. [**Openpath Security, Inc.**]
d. [**RS2 Technologies; ACRE, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**HID Global; ASSA ABLOY**]
b. [**IDTECK Global, Inc.**]
c. [**Openpath Security, Inc.**]
d. [**RS2 Technologies; ACRE, LLC**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Data ports for connection to LAN and downstream controllers.
b. Integral terminal blocks for connection of inputs/outputs to field devices.
c. Controller Inputs:

1) Auxiliary input.
2) Door contact.
3) Request to exit.
4) Cabinet tamper.
5) Power monitor.

d. Controller Outputs:

1) Auxiliary output.
2) Door strike.
3) Door operators.
4) Credential readers.

e. <**Insert characteristics**>.

5. Options:

a. Input Voltage: [**12 to 24 V(dc)**]<**Insert power input**>.
b. Operating Temperature: [**32 to 158 deg F (0 to 70 deg C)**]<**Insert temperature**>.
c. Controller Size: <**Insert size**>.
d. Controller Communication: [**Ethernet**][**TIA-232**][**TIA-485**]<**Insert type**>.
e. Mounting: [**Cabinet mount**]<**Insert mounting arrangement**>.

6. Operation:

a. <**Insert controller operating requirements**>.

7. Accessories:

a. <**Insert accessory**>.

F. Access Control System Input/Output Interface :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**LenelS2; Carrier Global Corporation**]
b. [**Openpath Security, Inc.**]

c. [**RS2 Technologies; ACRE, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**LenelS2; Carrier Global Corporation**]
b. [**Openpath Security, Inc.**]
c. [**RS2 Technologies; ACRE, LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Input Voltage: [**12 to 24 V(dc)**]<**Insert power input**>.
b. Operating Temperature: [**32 to 158 deg F (0 to 70 deg C)**]<**Insert temperature**>.
c. Size: <**Insert size**>.
d. Data ports for connection to LAN and downstream panels/controllers.
e. Integral terminal blocks for connection of inputs/outputs to field devices.
f. Inputs:

1) Auxiliary inputs from building systems.
2) Door contact.
3) Request to exit.
4) Cabinet tamper.
5) Power monitor.

g. Outputs:

1) Auxiliary outputs to building systems.
2) Door strike.
3) Credential readers.
4) Audible devices.

h. <**Insert characteristics**>.

5. Options:

a. Communication: [**Ethernet**][**TIA-232**][**TIA-485**]<**Insert type**>.
b. Mounting: [**Cabinet mount**]<**Insert mounting arrangement**>.

6. Operation:

a. <**Insert interface operating requirements**>.

7. Accessories:

a. <**Insert accessory**>.

2.2 ACCESS CONTROL SYSTEM POWER SUPPLIES AND BATTERY CHARGERS

A. Description: This category covers power supplies and battery chargers for access control system units,

controllers, input/output interfaces, workstations, printers, and encoders.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria: UL CCN ALVY; including UL 294.

C. Access Control System Power Supply and Battery Charger :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Altronix Corp.**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**LifeSafety Power (LSP); ASSA ABLOY**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Altronix Corp.**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**LifeSafety Power (LSP); ASSA ABLOY**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

a. Input Voltage: [**120 V(ac)**]<**Insert power input**>.
b. Output Voltage: [**12 to 24 V(dc)**]<**Insert power output**>.
c. Operating Temperature: [**32 to 120 deg F (0 to 49 deg C)**]<**Insert temperature**>.
d. Network connection for remote supervision, management, and testing.
e. Enclosure lock with tamper switch and monitoring.
f. Built-in battery charger.
g. Enclosure Size: <**Insert size**>.
h. Battery Size: <**Insert size**>.
i. Materials: [**Steel**]<**Insert material**>.
j. Finishes: <**Insert finish**>.
k. <**Insert characteristics**>.

5. Options:

a. Output Current: [**2.5 A**][**4 A**][**6 A**]<**Insert current**>.
b. Number of Outputs: [**One**][**Four**][**Eight**][**16**]<**Insert number**>.
c. Mounting: [**Wall mount**][**EIA/ECA-310 standard 19 inch (482.6 mm)**][**Rack mount**][**Cabinet mount**].

6. Operation:

    a. <**Insert power supply and charger operating requirements**>.

7. Accessories:

    a. DIN rails for mounting.

2.3 ACCESS CONTROL SYSTEM SUPPLEMENTARY COMPUTER EQUIPMENT

A. Description: This category covers access control system supplementary computer equipment that does not inhibit safety or intended operation of access control system hardware devices when they are shut off, lose power, or otherwise fail.

B. Performance Criteria:

1. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN NWGQ; including UL 294.

C. Access Control System Workstation :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Apple Inc.**]
    b. [**ASUSTek Computer Inc.**]
    c. [**Dell Technologies Inc.**]
    d. [**HP Inc.**]
    e. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
    f. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
    g. [**Microsoft Corporation**]
    h. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Apple Inc.**]
    b. [**ASUSTek Computer Inc.**]
    c. [**Dell Technologies Inc.**]
    d. [**HP Inc.**]
    e. [**Lenovo Holding Co., Inc.; Lenovo Group Ltd.**]
    f. [**LG Electronics USA, Inc.; LG Electronics Inc.**]
    g. [**Microsoft Corporation**]
    h. [**Samsung Electronics America, Inc. (SEA); Samsung Electronics Co., Ltd. (SEC)**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Input Voltage: [**120 V(ac)**]<**Insert power input**>.
    b. Operating Temperature: [**50 to 82 deg F (10 to 28 deg C)**]<**Insert temperature**>.
    c. Ethernet port for connection to LAN/WAN.
    d. PC-based operating system with high-definition display.
    e. <**Insert characteristics**>.

5. Options:

    a. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system and version**>.
    b. Display Size: [**22 inch (560 mm)**][**24 inch (610 mm)**]<**Insert size**>.
    c. Display Resolution: [**1280×720**][**1920×1080**]<**Insert resolution**>.
    d. Drive Space: [**100 GB**][**500 GB**][**1 TB**]<**Insert size**>.
    e. Memory: [**16 GB**][**24 GB**][**32 GB**][**48 GB**]<**Insert size**> RAM.
    f. User Control: [**Touchscreen**][**and**][**or**][**keyboard and mouse**].
    g. Mounting: [**EIA/ECA-310 standard 19 inch (482.6 mm)**][**Rack mount**][**Cabinet mount**][**desktop mount**].

6. Operation:

    a. <**Insert workstation operating requirements**>.

7. Accessories:

    a. Printer for identification/credential cards.
    b. Encoder for programming of access control credentials.
    c. <**Insert accessory**>.

D. Access Control System Printers and Encoders :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**HID Global; ASSA ABLOY**]
    b. [**Magicard Ltd.**]
    c. [**Zebra Technologies Corp.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**HID Global; ASSA ABLOY**]
    b. [**Magicard Ltd.**]
    c. [**Zebra Technologies Corp.**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Password-protected access for secure printing.
    b. User Control: Touchscreen graphical display.

c. Mounting: Desktop mounted.
d. <**Insert characteristics**>.

5. Options:

a. Input Voltage: [**100 to 240 V(ac)**]<**Insert power input**>.
b. Operating Temperature: [**65 to 80 deg F (18 to 27 deg C)**]<**Insert temperature**>.
c. Operating System: [**Windows 7**][**Windows 10**]<**Insert operating system and version**>.
d. Data Connection: [**USB 2.0**][**Ethernet**]<**Insert connection type**>.
e. Standard Card Size: [**CR-79**][**CR-80**]<**Insert size**>.
f. Printing Resolution: [**300 dpi**]<**Insert resolution**>.
g. Memory: [**16 MB**][**32 MB**][**1 GB**]<**Insert size**> RAM.
h. Access Control Credential Programming: [**Proximity smart card**][**Magnetic stripe card**].
i. Interface with secure visitor management solutions.

6. Operations:

a. <**Insert printer and encoder operating requirements**>.

7. Accessories:

a. WiFi accessory for Ethernet-enabled printers.
b. <**Insert accessory**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM HARDWARE

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Installation of Access Control System Hardware and Wiring: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with requirements in guide information for UL CCN ALVY.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions**>.

D. Interfaces with Other Work:

1. Coordinate installation of new products for access control system hardware with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Section 281000 "Access Control" for physical and functional interfaces with access control system and for compliance with system-wide performance requirements.
3. Coordinate with [**Section 284600 "Fire Detection and Alarm"**][**and**][**Section 284614 "Single-**

and Multiple-Station Alarms"] for interfacing security system inputs/outputs with fire-alarm system inputs/outputs.

E. Systems Integration:

1. <**Insert requirements for integration with other systems**>.

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SYSTEM HARDWARE

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Hardware and components will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps**>.

3.4 ADJUSTING

A. Adjust printers and ribbons to function smoothly, and lubricate as recommended in writing by manufacturer.

3.5 PROTECTION

A. After installation, protect access control system hardware from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 28 10 00 00B

SECTION 28 15 00 00 - INTEGRATED ACCESS CONTROL HARDWARE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Integrated credential readers and entry management.
2. Access control credentials.
3. Electrified locking devices and accessories.
4. Egress management devices.
5. Access control remote devices.
6. Electronic key management systems.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281511 "Integrated Credential Readers and Entry Management" for additional integrated access control hardware device products.
5. Section 281513 "Access Control Credentials" for additional access control hardware credential products.
6. Section 281515 "Electrified Locking Devices and Accessories" for additional electronically controlled lock and latch products.
7. Section 281517 "Egress Management Devices" for additional access control hardware device products intended for use along the means of egress.
8. Section 281519 "Access Control Remote Devices" for additional wireless access control hardware device products.
9. Section 281521 "Telephone Entry Systems" for access control telephone entry products.
10. Section 281523 "Intercom Entry Systems" for access control intercom entry products.
11. Section 281525 "Electronic Key Management Systems" for additional key management system products with access control interfaces.
12. Section 281527 "Access Control Electronic Turnstiles and Mobility Systems" for security turnstile operator products with access control interfaces.

1.2 DEFINITIONS

A. BMS: Building management system.

B. NFC: Near Field Communications.

C. PoE: Power over Ethernet.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For integrated access control hardware devices. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for integrated credential readers and entry management devices.
2. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
3. Printing, programming, and handling instructions for access control credentials.
4. Installation instructions for electrified locking devices and accessories.
5. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
6. Installation instructions for egress management devices.
7. Manufacturer's recommended tests and inspections for egress management devices.
8. Installation instructions for access control remote devices.
9. Manufacturer's recommended tests and inspections for access control remote devices.
10. Installation instructions for electronic key management systems.
11. Manufacturer's recommended tests and inspections for electronic key management systems.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreements.

B. Warranty documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials**[, from same production run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Integrated Credential Readers and Entry Management Devices: [**One**]<**Insert number**> of each type.
2. Electrified Locking Devices and Accessories: [**One**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to integrated access control hardware devices, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.8 REGULATORY AGENCY APPROVALS FOR EGRESS MANAGEMENT DEVICES

A. Submittals for egress management devices requiring approval by authorities having jurisdiction must be signed and sealed by qualified life safety professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

B. Submittals for egress management devices require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.9 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.10 WARRANTY

A. Integrated Credential Readers and Entry Management Devices Warranty:

1. Special Installer Extended Warranty: Installer warrants that fabricated and installed integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

a. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

2. Special Manufacturer Extended Warranty: Manufacturer warrants that integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

a. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
b. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

B. Electrified Locking Devices and Accessories Warranty:

1. Special Installer Extended Warranty: Installer warrants that fabricated and installed electrified locking devices and accessories perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

a. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

2. Special Manufacturer Extended Warranty: Manufacturer warrants that electrified locking devices and accessories perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

a. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
b. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

A. Swipe Card Reader :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**aptiQ; an Allegion brand**]
b. [**Cansec Systems Ltd.**]
c. [**HID Global; ASSA ABLOY**]
d. [**Peripheral Dynamics, Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**aptiQ; an Allegion brand**]
b. [**Cansec Systems Ltd.**]
c. [**HID Global; ASSA ABLOY**]
d. [**Peripheral Dynamics, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) UL CCN ALVY; including UL 294.
2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

c. General Characteristics: Visual LED indication of card read.

5. Options:

a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
b. Input Voltage: [**5 to 12 V(dc)**]<**Insert power input**>.
c. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
d. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
e. Colors: [**Black**][**Gray**]<**Insert color**>.
f. Climate: [**Indoor**][**and**][**outdoor**].
g. Size: [**Single gang**][**or**][**double gang**].

B. Proximity Reader for Card, Fob, or Smartphone :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMAG Technology; G4S USA**]
b. [**aptiQ; an Allegion brand**]
c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
d. [**HID Global; ASSA ABLOY**]
e. [**IDenticard Systems; Precision Dynamics Corporation**]
f. [**Openpath Security, Inc.**]
g. [**XceedID; an Allegion brand**]

h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AMAG Technology; G4S USA**]
   b. [**aptiQ; an Allegion brand**]
   c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   d. [**HID Global; ASSA ABLOY**]
   e. [**IDenticard Systems; Precision Dynamics Corporation**]
   f. [**Openpath Security, Inc.**]
   g. [**XceedID; an Allegion brand**]
   h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

   a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   b. Listing Criteria:

      1) UL CCN ALVY; including UL 294.
      2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

   c. General Characteristics: Visual LED indication of card read.

5. Options:

   a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   b. Input Voltage: [**5 to 16 V(dc)**][**PoE**]<**Insert power input**>.
   c. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
   d. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**].
   e. Transmit Frequency: [**125 kHz**][**13.56 MHz**][**2.4 GHz**].
   f. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   g. Colors: [**Black**][**Gray**]<**Insert color**>.
   h. Climate: [**Indoor**][**and**][**outdoor**].
   i. Size: [**Single gang**][**or**][**double gang**].

6. Accessories:

   a. Long-range receiver module.

C. Door Lock Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alarm Lock; NAPCO Security Technologies, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alarm Lock; NAPCO Security Technologies, Inc.**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

    a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    b. Listing Criteria:

        1) UL CCN ALVY; including UL 294.
        2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Options:

    a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
    b. Visual LED indication of [**three-**][**or**][**six-**]digit code read.
    c. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**][**Alkaline batteries**]<**Insert power input**>.
    d. Operating Temperature: [**Minus 20 to plus 150 deg F (Minus 29 to plus 66 deg C)**]<**Insert temperature**>.
    e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
    f. Colors: [**Black**][**Gray**]<**Insert color**>.
    g. Climate: [**Indoor**][**and**][**outdoor**].
    h. Size: [**Single gang**][**or**][**double gang**].
    i. Mounting:

        1) Door/window mullions.
        2) Outlet boxes.
        3) Flat surfaces.
        4) Integrated door lock keypad.

D. Scramble Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Hirsch; a brand of Identiv, Inc.**]
    b. [**Schlage; an Allegion brand**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Hirsch; a brand of Identiv, Inc.**]
    b. [**Schlage; an Allegion brand**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Performance Criteria:

    a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    b. Listing Criteria:

        1) UL CCN ALVY; including UL 294.
        2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Options:

    a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
    b. Visual LED indication of [**three-**][**or**][**six-**][**or**][**nine-**]digit code read.
    c. Input Power: [**8 to 12 V(dc)**]<**Insert power input**>.
    d. Operating Temperature: [**5 to 122 deg F (Minus 15 to plus 50 deg C)**]<**Insert operating temperature**>.
    e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
    f. Colors: [**Black**][**Gray**]<**Insert color**>.
    g. Climate: [**Indoor**][**and**][**outdoor**].
    h. Mounting: [**Single-gang**][**or**][**double-gang**] outlet box.

E. Combination Card Reader and Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
    b. [**Hirsch; a brand of Identiv, Inc.**]
    c. [**Open Options; ACRE, LLC**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
    b. [**Hirsch; a brand of Identiv, Inc.**]
    c. [**Open Options; ACRE, LLC**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

    a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    b. Listing Criteria:

        1) UL CCN ALVY; including UL 294.
        2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

    c. General Characteristics: Visual LED indication of code and/or card read.

5. Options:

a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
b. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**]<**Insert power input**>.
c. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
d. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
e. Colors: [**Black**][**Gray**][**White**]<**Insert color**>.
f. Climate: [**Indoor**][**and**][**outdoor**].
g. Mounting:

1) Surface mount.
2) Triple-gang wall box.

2.2 ACCESS CONTROL CREDENTIALS

A. Access Control Cards :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. [**Hirsch; a brand of Identiv, Inc.**]
e. [**Honeywell Commercial Security; Honeywell International, Inc.**]
f. [**IDenticard Systems; Precision Dynamics Corporation**]
g. [**IDTECK Global, Inc.**]
h. [**Viking Electronics, Inc.**]
i. [**XceedID; an Allegion brand**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. [**Hirsch; a brand of Identiv, Inc.**]
e. [**Honeywell Commercial Security; Honeywell International, Inc.**]
f. [**IDenticard Systems; Precision Dynamics Corporation**]
g. [**IDTECK Global, Inc.**]
h. [**Viking Electronics, Inc.**]
i. [**XceedID; an Allegion brand**]
j. <**Insert manufacturer's name**>

3. Performance Criteria:

a. Reference Standards:

1) Personal Identity Verification (PIV): FIPS PUB 201-2.
2) Physical: IEC 7810; IEC 10373; IEC 7816 for contact cards; and IEC 14443 for contactless cards.

3) Functional: UL 294; IEC 60839-11-1; and IEC 60839-11-2.
4) Material Durability: INCITS 322.

b. Format: Customizable, including artwork.[**Provide credential template with provisions for the following:**]

1) On Front: Photograph, full name (surname first), affiliation, organization, card expiration date, color-coding, Owner's name, Owner's logo, two-dimensional bar code.
2) On Back: Physical characteristics of cardholder, employee ID number, card number, magnetic stripe, linear bar code, return address. Include the following message:

a) <**Insert message**>.

3) Stored Data Elements: PIN, employee ID number, two fingerprint templates, electronic facial image, one iris image, digital signature private key and certificate, key management private key and certificate, card authenticate data, and PIV authentication data.

4. Options:

a. Data Format: Wiegand [**26 bit**][**34 bit**][**37 bit**].
b. Transmit Frequency: [**125 kHz**][**and**][**13.56 MHz**].
c. Data Retention: [**10**][**20**] years.
d. Memory Capacity: [**2.5 kB**][**8 kB**][**16 kB**][**32 kB**].
e. Operating Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**].
f. Materials: [**Plastic**][**ABS**][**PVC laminate**].
g. Color: [**White**][**Off-white**][**Glossy white**]<**Insert color**>.
h. Reading Medium: [**Multi-criteria use**][**Proximity**][**and**][**chip**][**and**][**magnetic strip**].

2.3 ELECTRIFIED LOCKING DEVICES AND ACCESSORIES

A. Electrically Controlled Single-Point Latch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**Design Hardware; Mesker Openings Group; dormakaba**]
c. [**Schlage; an Allegion brand**]
d. [**Security Door Controls**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**Design Hardware; Mesker Openings Group; dormakaba**]
c. [**Schlage; an Allegion brand**]
d. [**Security Door Controls**]

e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
2) Electrically Controlled Single-Point Locks and Latches: UL CCN GYQS, UL 10B, and UL 10C; designed to be used with Class 2 control-voltage circuits in accordance with Article 725 of NFPA 70.

5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**AA batteries**]<**Insert power input**>.
c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated Credential Reader:

1) Proximity (125 kHz).
2) Smart (13.56 MHz).
3) Bluetooth, low energy (2.4 GHz).
4) NFC.

h. Integrated [**combination lock**][**keypad**].
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Latch bolt monitor.
l. [**With**][**or**][**without**] deadbolt.

B. Electrically Controlled Three-Point Latches :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
2) Two- and Three-Point Locks and Latches: UL CCN GYXR; including UL 10B.

5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**]<**Insert power input**>.
c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated Credential Reader:

1) Proximity (125 kHz).
2) Smart (13.56 MHz).
3) Bluetooth, low energy (2.4 GHz).
4) NFC.

h. Integrated [**combination lock**][**keypad**].
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Latch bolt monitor.

C. Type 1 High-Security Electronic Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**FireKing International**]
d. [**NKL Industries Ltd.; FireKing International LLC**]
e. [**SARGENT Manufacturing Company; ASSA ABLOY**]
f. [**SECURAM Systems Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**American Security Products Co.**]
    b. [**dormakaba USA Inc.**]
    c. [**FireKing International**]
    d. [**NKL Industries Ltd.; FireKing International LLC**]
    e. [**SARGENT Manufacturing Company; ASSA ABLOY**]
    f. [**SECURAM Systems Inc.**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

    a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    b. Listing Criteria:

        1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
        2) High-Security Electronic Locks: UL CCN OZDC; including UL Subject 2058.
        3) Type 1 Locks: UL CCN OZDU.

5. Options:

    a. [**Audible**][**and**][**visual**] indication of door unlock.
    b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**]<**Insert power input**>.
    c. Operating Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert temperature**>.
    d. Connectivity: [**Hardwired**][**Wireless**].
    e. Memory:

        1) Access time/date stamp stored in [**key**][**and**][**cylinder**].
        2) Audit Trail: [**100**][**1000**]<**Insert number**> events.
        3) Directory of authorized keys stored in cylinder.

    f. Cylinder Type: [**Single**][**Double**][**Mortise**]<**Insert type**>.
    g. Materials: [**Zinc**][**Steel**]<**Insert material**>.
    h. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
    i. Integrated credential reader.
    j. Failure Mode: [**Fail-safe**][**Fail-secure**].
    k. Mechanical key override.

D. Type 1F High-Security Electronic Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Kaba Mas - LA GARD; dormakaba Group**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**Kaba Mas - LA GARD; dormakaba Group**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
2) High-Security Electronic Locks: UL CCN OZDC; including UL Subject 2058.
3) Type 1F Locks: [**UL CCN OZEM; including**]Fed. Spec. FF-L-2740.

5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**]<**Insert power input**>.
c. Operating Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**][**Steel**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Failure Mode: [**Fail-safe**][**Fail-secure**].
h. Mechanical key override.

E. Request-to-Exit (REX) Motion Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Vicon Industries, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Vicon Industries, Inc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria: UL CCN ALVY; including UL 294.

5. Options:

a. Input Power: [**125 V(ac)**]<**Insert power input**>.
b. Operating Temperature: [**Minus 13 to plus 140 deg F (Minus 25 to plus 60 deg C)**]<**Insert temperature**>.
c. Sensing Technology: [**Passive infrared (PIR)**][**Active infrared (AIR)**].
d. Color: [**Black**][**Gray**][**White**]<**Insert color**>.
e. Mounting: [**Wall surface**][**Recessed in ceiling**][**Door frame**].

F. Request-to-Exit (REX) Push Button :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Schlage; an Allegion brand**]
c. [**Von Duprin; Allegion plc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Schlage; an Allegion brand**]
c. [**Von Duprin; Allegion plc**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria: UL CCN ALVY; including UL 294.

5. Options:

a. Input Power: [**12 to 24 V(ac/dc)**]<**Insert power input**>.
b. Operating Temperature: [**Minus 13 to plus 140 deg F (Minus 25 to plus 60 deg C)**]<**Insert operating temperature**>.
c. Operating Mechanism: [**Pneumatic**][**Piezoelectric**].
d. Faceplate Material: [**Stainless steel**]<**Insert material**>.
e. Button Material: [**Plastic**][**Anodized aluminum**]<**Insert material**>.
f. Button Color: [**Green**][**Blue**][**Red**]<**Insert color**>.
g. Lettering Color: [**White**][**Black**]<**Insert color**>.
h. Failure Mode: [**Fail-safe**][**Fail-secure**].

2.4 EGRESS MANAGEMENT DEVICES

A. Magnetic Lock Hardware with Special Locking Arrangement for Fire-Rated Doors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**BEA Americas; Halma plc**]
    c. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
    d. [**Hager Companies**]
    e. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
    f. [**SARGENT Manufacturing Company; ASSA ABLOY**]
    g. [**Schlage; an Allegion brand**]
    h. [**Vanguard Security Engineering Corp. (VGSE)**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**BEA Americas; Halma plc**]
    c. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
    d. [**Hager Companies**]
    e. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
    f. [**SARGENT Manufacturing Company; ASSA ABLOY**]
    g. [**Schlage; an Allegion brand**]
    h. [**Vanguard Security Engineering Corp. (VGSE)**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

    a. Regulatory Requirements:

        1) Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
        2) Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

    b. Listing Criteria:

        1) Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
        2) Electromagnetic Locks for Fire-Rated Doors: UL CCN GWXT; including UL 10B and UL 10C.

5. Options:

    a. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.
    b. Holding Force: [**1200 lbf (5338 N)**]<**Insert force**>.

c. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.
d. Relock Function: [**Manual**][**Delayed automatic**] relock.
e. Door Prop Alarm Delay: [**None**][**30 seconds**]<**Insert delay**>.
f. Door Movement Detection: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].
g. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].

B. Panic Hardware with Special Locking Arrangement for Fire-Rated Doors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
c. [**Detex Corporation**]
d. [**Kaba Mas - LA GARD; dormakaba Group**]
e. [**Von Duprin; Allegion plc**]
f. [**Yale Security Inc; ASSA ABLOY**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
c. [**Detex Corporation**]
d. [**Kaba Mas - LA GARD; dormakaba Group**]
e. [**Von Duprin; Allegion plc**]
f. [**Yale Security Inc; ASSA ABLOY**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Performance Criteria:

a. Regulatory Requirements:

1) Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2) Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
2) Panic Hardware for Fire-Rated Doors: UL CCN GXHX, UL 10C, and UL 305.
3) Controlled-Exit Panic Devices: UL CCN FULA; including UL 305.

5. Options:

a. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.
b. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.

c. Door Prop Alarm: [**None**][**Activate after 30 seconds**]<**Insert delay**>.
d. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].
e. Secondary Power: [**9 V battery**]<**Insert power source**>.

2.5 ACCESS CONTROL REMOTE DEVICES

A. Near Field Communications (NFC) Access Control Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**AMAG Technology; G4S USA**]
b. [**aptiQ; an Allegion brand**]
c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
d. [**HID Global; ASSA ABLOY**]
e. [**IDenticard Systems; Precision Dynamics Corporation**]
f. [**Schlage; an Allegion brand**]
g. [**XceedID; an Allegion brand**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**AMAG Technology; G4S USA**]
b. [**aptiQ; an Allegion brand**]
c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
d. [**HID Global; ASSA ABLOY**]
e. [**IDenticard Systems; Precision Dynamics Corporation**]
f. [**Schlage; an Allegion brand**]
g. [**XceedID; an Allegion brand**]
h. <**Insert manufacturer's name**>

3. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria: UL CCN ALVY; including UL 294.

4. Options:

a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
b. Input Voltage: [**5 to 12 V(dc)**][**PoE**]<**Insert voltage**>.
c. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
d. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**].
e. Transmit Frequency: [**125 kHz**][**13.56 MHz**].
f. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
g. Colors: [**Black**][**Gray**]<**Insert color**>.
h. Climate: [**Indoor**][**and**][**outdoor**].
i. Size: [**Single gang**][**or**][**double gang**].

2.6 ELECTRONIC KEY MANAGEMENT SYSTEMS

A. Electronic Key Management System Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**MATRIX Cabinet**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**MATRIX Cabinet**]
d. <**Insert manufacturer's name**>

3. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria: UL CCN ALZK; including UL 294.

4. Options:

a. Input Voltage: [**110 to 240 V(ac)**]<**Insert voltage**>.
b. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
c. Key Storage Capacity: <**Insert number**>.
d. Operating Frequency: [**125 kHz**][**13.56 MHz**].
e. Materials: [**Stainless steel**]<**Insert material**>.
f. Finishes: [**Powder coated**]<**Insert finish**>.
g. Backup Battery: [**12 V(dc)**]<**Insert battery size**>.
h. Front Cover: [**Clear display window**][**Solid panel**].
i. Enclosure Size: <**Insert size**>.

5. Operation:

a. Access Method: [**Proximity card**][**and**][**biometrics**][**and**][**keypad**][**and**][**standard key**].
b. Alarm output: [**Local sounder**][**Output contacts**].

PART 3 - EXECUTION

3.1 DEPLOYMENT OF CREDENTIALS

A. Comply with manufacturer's published instructions.

B. Third-Party Issuing of Access Control Credentials:

1. Printing of New Credentials: Contractor must be capable of programming and issuing credentials compatible with Owner's access control system.

a. Initial Issuance: Provide spreadsheet or form for collecting data for generation of credentials. Owner will submit completed form containing data for personnel to be issued credentials. Print and provide initial run, printed and programmed credentials in specified format within [**four**]<**Insert number**> weeks of request.
b. Ongoing Issuance: Produce additional credentials upon Owner request. Owner will submit completed form containing data for personnel to be issued credentials. Print and program credentials in specified format within [**one**][**two**] weeks of request.

3.2 INSTALLATION OF INTEGRATED ACCESS CONTROL HARDWARE DEVICES

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
2. Analog Maximum Cable Length: [**1000 ft (300 m)**]<**Insert cable length**>.
3. Digital Maximum Cable Length: [**300 ft (100 m)**][**500 ft (150 m)**]<**Insert cable length**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for access control hardware devices with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate access control credentials with integrated credential readers and access control system architecture.
3. Egress Management Interfaces:

a. Coordinate with Section 282000 "Video Surveillance" for automatic video feed callup upon delayed egress activation.
b. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC" for monitoring of egress management device alarms by BMS.
c. Coordinate with Section 284600 "Fire Detection and Alarm" for monitoring of egress management device alarms by fire-alarm system.

3.3 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service**

representative].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.4 PROTECTION

A. After installation, protect integrated access control hardware devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00

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SECTION 28 15 00 00A - ACCESS CONTROL CREDENTIALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access control credentials.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official deployment[**and testing**] instructions issued to Contractor by manufacturer for the following:

1. Printing, programming, and handling instructions for access control credentials.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS FOR CONTINUED USE

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 ACCESS CONTROL CREDENTIALS

A. Access Control Cards :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. [**Hirsch; a brand of Identiv, Inc.**]
e. [**Honeywell Commercial Security; Honeywell International, Inc.**]
f. [**IDenticard Systems; Precision Dynamics Corporation**]
g. [**IDTECK Global, Inc.**]
h. [**Viking Electronics, Inc.**]
i. [**XceedID; an Allegion brand**]
j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. [**Hirsch; a brand of Identiv, Inc.**]
e. [**Honeywell Commercial Security; Honeywell International, Inc.**]
f. [**IDenticard Systems; Precision Dynamics Corporation**]
g. [**IDTECK Global, Inc.**]
h. [**Viking Electronics, Inc.**]
i. [**XceedID; an Allegion brand**]
j. <**Insert manufacturer's name**>

3. Standard Features:

a. Reference Standards:

1) Personal Identity Verification (PIV): FIPS PUB 201-2.
2) Physical: IEC 7810; IEC 10373; IEC 7816 for contact cards; and IEC 14443 for contactless cards.
3) Functional: UL 294; IEC 60839-11-1; and IEC 60839-11-2.
4) Material Durability: INCITS 322.

b. Configuration: Customizable, including artwork.[**Provide credential template with provisions for the following:**]

1) On Front: Photograph, full name (surname first), affiliation, organization, card expiration date, color-coding, Owner's name, Owner's logo, two-dimensional bar code.
2) On Back: Physical characteristics of cardholder, employee ID number, card number, magnetic stripe, linear bar code, return address. Include the following message:

a) <**Insert message**>.

3) Stored Data Elements: PIN, employee ID number, two fingerprint templates, electronic facial image, one iris image, digital signature private key and certificate, key management private key and certificate, card authenticate data, and PIV authentication data.

c. Data Format: Wiegand [**26 bit**][**34 bit**][**37 bit**].

d. Transmit Frequency: [**125 kHz**][**and**][**13.56 MHz**].
e. Data Retention: [**10**][**20**] years.
f. Memory Capacity: [**2.5 kB**][**8 kB**][**16 kB**][**32 kB**].
g. Operating Temperature: [**Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**]<**Insert temperature range**>.
h. Materials: [**Plastic**][**ABS**][**PVC laminate**].
i. Color: [**White**][**Off-white**][**Glossy white**]<**Insert color**>.
j. Reading Medium: [**Multi-criteria use**][**Proximity**][**and**][**chip**][**and**][**magnetic strip**].

B. Wireless Key Fobs :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
c. [**HID Global; ASSA ABLOY**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Reference Standards:

1) Physical: IEC 7810; IEC 10373; IEC 7816 for contact cards; and IEC 14443 for contactless cards.
2) Functional: UL 294; IEC 60839-11-1; and IEC 60839-11-2.
3) Material Durability: INCITS 322.

b. Configuration: Customizable, including artwork.

1) Stored Data Elements: PIN, employee ID number, two fingerprint templates, electronic facial image, one iris image, digital signature private key and certificate, key management private key and certificate, and card authenticate data.

c. Memory: [**1 kB**][**4 kB**][**80 kB**].
d. Operating Temperature: [**Minus 49 to plus 185 deg F (Minus 45 to plus 85 deg C)**]<**Insert temperature range**>.
e. Transmit Frequency: [**125 kHz**][**and**][**13.56 MHz**].
f. Read Range: Up to [**3/4 inch (19 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**][**4 inch (102 mm)**].
g. Format: Wiegand [**26 bit**][**37 bit**].
h. Data Retention: [**10**][**20**] years.
i. Materials: [**Plastic**][**Epoxy**][**Polycarbonate**][**ABS shell with TPE insert**].
j. Color: [**Dark gray**][**Black**][**Transparent blue**][**White**]<**Insert color**>.
k. Connector: USB 2.0 connector, Type A (male).

l. External numbering.

4. Accessories:

a. Key ring.

PART 3 - EXECUTION

3.1 DEPLOYMENT

A. Comply with manufacturer's published instructions.

B. Third-Party Issuing of Access Control Credentials:

1. Printing of New Credentials: Contractor must be capable of programming and issuing credentials compatible with Owner's access control system.

a. Initial Issuance: Provide spreadsheet or form for collecting data for generation of credentials. Owner will submit completed form containing data for personnel to be issued credentials. Print and provide initial run, printed and programmed credentials in specified format within [**four**]<**Insert number**> weeks of request.
b. Ongoing Issuance: Produce additional credentials upon Owner request. Owner will submit completed form containing data for personnel to be issued credentials. Print and program credentials in specified format within [**one**][**two**] weeks of request.

C. Interfaces with Other Work:

1. Coordinate access control credentials with integrated credential readers and access control system architecture.

END OF SECTION 28 15 00 00A

SECTION 28 15 00 00B - ELECTRIFIED LOCKING DEVICES AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrically controlled single-point locks and latches.
2. Electrically controlled two- and three-point locks and latches.
3. High-security electronic locks.
4. Status monitoring and egress devices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 DEFINITIONS

A. NFC: Near Field Communications.

B. PoE: Power over Ethernet.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For electrified locking devices and accessories. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Electrically controlled single-point locks and latches.
2. Electrically controlled two- and three-point locks and latches.
3. High-security electronic locks.
4. Status monitoring and egress devices.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for electrified locking devices and accessories.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Firmware service agreement.

B. Warranty documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Electrified Locking Devices and Accessories: [**One**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to electrified locking devices and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.8 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.9 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed electrified locking devices and accessories perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that electrified locking devices and accessories perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 ELECTRICALLY CONTROLLED SINGLE-POINT LOCKS AND LATCHES

A. Description: This category covers single-point electrified locksets, including cylindrical and mortise-style locks, which are connected to the access control system via hardwired cabling or wireless. Electrified locksets communicate with credential readers through the access control system to unlock doors upon credential authorization. Electrified locksets may also be programmed to lock or unlock directly via a signal from the access control system without the need for credential authorization.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.

b. Electrically Controlled Single-Point Locks and Latches: UL CCN GYQS, UL 10B, and UL 10C; designed to be used with Class 2 control-voltage circuits in accordance with Article 725 of NFPA 70.

C. Electrically Controlled Single-Point Latch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
   b. [**Design Hardware; Mesker Openings Group; dormakaba**]
   c. [**Schlage; an Allegion brand**]
   d. [**Security Door Controls**]
   e. [**Yale Security Inc; ASSA ABLOY**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
   b. [**Design Hardware; Mesker Openings Group; dormakaba**]
   c. [**Schlage; an Allegion brand**]
   d. [**Security Door Controls**]
   e. [**Yale Security Inc; ASSA ABLOY**]
   f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

   a. [**Audible**][**and**][**visual**] indication of door unlock.
   b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**AA batteries**]<**Insert power input**>.
   c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
   d. Connectivity: [**Hardwired**][**Wireless**].
   e. Materials: [**Zinc**]<**Insert material**>.
   f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
   g. Integrated Credential Reader:

      1) Proximity (125 kHz).
      2) Smart (13.56 MHz).
      3) Bluetooth low energy (2.4 GHz).
      4) NFC.

   h. Integrated [**combination lock**][**keypad**].
   i. Failure Mode: [**Fail-safe**][**Fail-secure**].
   j. Mechanical key override.
   k. Latch bolt monitor.
   l. [**With**][**or**][**without**] deadbolt.

2.2 ELECTRICALLY CONTROLLED TWO- AND THREE-POINT LOCKS AND LATCHES

A. Description: This category covers two- and three-point electrified locksets, which are connected to the access control system via hardwired cabling or wireless. Electrified locksets communicate with credential readers through the access control system to unlock doors upon credential authorization. Electrified locksets may also be programmed to lock or unlock directly via a signal from the access control system without the need for credential authorization.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
b. Two- and Three-Point Locks and Latches: UL CCN GYXR; including UL 10B.

C. Electrically Controlled Two-Point Latch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**]<**Insert power input**>.
c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated Credential Reader:

1) Proximity (125 kHz).
2) Smart (13.56 MHz).

3) Bluetooth low energy (2.4 GHz).
4) NFC.

h. Integrated [**combination lock**][**keypad**].
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Latch bolt monitor.

D. Electrically Controlled Three-Point Latch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
b. [**SARGENT Manufacturing Company; ASSA ABLOY**]
c. [**Schlage; an Allegion brand**]
d. [**Von Duprin; Allegion plc**]
e. [**Yale Security Inc; ASSA ABLOY**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**]<**Insert power input**>.
c. Operating Temperature: [**Minus 31 to plus 151 deg F (Minus 35 to plus 66 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated Credential Reader:

1) Proximity (125 kHz).
2) Smart (13.56 MHz).
3) Bluetooth low energy (2.4 GHz).
4) NFC.

h. Integrated [**combination lock**][**keypad**].
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Latch bolt monitor.

2.3 HIGH-SECURITY ELECTRONIC LOCKS

A. Description: This category covers high-security electronic locks, which are connected to the access control system via hardwired cabling or wireless. High-security electronic locks typically have multilevel authentication or utilize heavy-duty components for increased security.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
b. High-Security Electronic Locks: UL CCN OZDC; including UL Subject 2058.

C. Type 1 High-Security Electronic Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**FireKing International**]
d. [**NKL Industries Ltd.; FireKing International LLC**]
e. [**SARGENT Manufacturing Company; ASSA ABLOY**]
f. [**SECURAM Systems Inc.**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**FireKing International**]
d. [**NKL Industries Ltd.; FireKing International LLC**]
e. [**SARGENT Manufacturing Company; ASSA ABLOY**]
f. [**SECURAM Systems Inc.**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Listing Criteria: UL CCN OZDU.
5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**]<**Insert power input**>.
c. Operating Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Memory:

1) Access time/date stamp stored in [**key**][**and**][**cylinder**].

2) Audit Trail: [**100**][**1000**]<**Insert number**> events.
3) Directory of authorized keys stored in cylinder.

f. Cylinder Type: [**Single**][**Double**][**Mortise**]<**Insert type**>.
g. Materials: [**Zinc**][**Steel**]<**Insert material**>.
h. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
i. Integrated credential reader.
j. Failure Mode: [**Fail-safe**][**Fail-secure**].
k. Mechanical key override.

D. Type 1F High-Security Combination Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kaba Mas - LA GARD; dormakaba Group**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Kaba Mas - LA GARD; dormakaba Group**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Listing Criteria: [**UL CCN OZEM; including**]Fed. Spec. FF-L-2740.
5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**][**Electromechanically self-powered**]<**Insert power input**>.
c. Operating Temperature: [**Minus 10 to plus 155 deg F (Minus 23 to plus 68 deg C)**]<**Insert temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**][**Steel**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Failure Mode: [**Fail-safe**][**Fail-secure**].
h. Mechanical key override.

E. Type 2 High-Security Combination Lock :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**NKL Industries Ltd.; FireKing International LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

a. [**American Security Products Co.**]
b. [**dormakaba USA Inc.**]
c. [**NKL Industries Ltd.; FireKing International LLC**]
d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Listing Criteria: UL CCN OZFE.
5. Options:

a. [**Audible**][**and**][**visual**] indication of door unlock.
b. Input Power: [**12 V(ac/dc)**][**or**][**24 V(ac/dc)**][**PoE**][**Li-ion battery**]<**Insert power input**>.
c. Operating Temperature: [**Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C)**]<**Insert operating temperature**>.
d. Connectivity: [**Hardwired**][**Wireless**].
e. Materials: [**Zinc**][**Steel**]<**Insert material**>.
f. Finishes: [**US26D Satin Chrome**]<**Insert finish**>.
g. Integrated credential reader.
h. Request-to-Exit (REX) switch.
i. Failure Mode: [**Fail-safe**][**Fail-secure**].
j. Mechanical key override.
k. Keyed Cylinder Configurations:

1) Standard key in lever.
2) Small-format interchangeable core (SFIC).
3) Yale large-format removeable core.

2.4 STATUS MONITORING AND EGRESS DEVICES

A. Description: This category covers egress devices and sensors, which are installed integral to or adjacent to door assemblies. Equipment under this category may be interconnected to other access control equipment, such as credential readers and locking devices. Equipment under this category may also be directly connected to the access control system to report door status.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.

C. Request-to-Exit (REX) Motion Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Vicon Industries, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
    b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
    c. [**Vicon Industries, Inc**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

    a. Input Power: [**125 V(ac)**]<**Insert power input**>.
    b. Operating Temperature: [**Minus 13 to plus 140 deg F (Minus 25 to plus 60 deg C)**]<**Insert temperature**>.
    c. Sensing Technology [**Passive infrared (PIR)**][**Active infrared (AIR)**].
    d. Color: [**Black**][**Gray**][**White**]<**Insert color**>.
    e. Mounting: [**Wall surface**][**Recessed in ceiling**][**Door frame**].

D. Request-to-Exit (REX) Push Button :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
    b. [**Schlage; an Allegion brand**]
    c. [**Von Duprin; Allegion plc**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
    b. [**Schlage; an Allegion brand**]
    c. [**Von Duprin; Allegion plc**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Options:

    a. Input Power: [**12 to 24 V(ac/dc)**]<**Insert power input**>.
    b. Operating Temperature: [**Minus 13 to plus 140 deg F (Minus 25 to plus 60 deg C)**]<**Insert temperature**>.
    c. Operating Mechanism: [**Pneumatic**][**Piezoelectric**].
    d. Faceplate Material: [**Stainless steel**]<**Insert material**>.
    e. Button Material: [**Plastic**][**Anodized aluminum**]<**Insert material**>.
    f. Button Color: [**Green**][**Blue**][**Red**]<**Insert color**>.
    g. Lettering Color: [**White**][**Black**]<**Insert color**>.
    h. Failure Mode: [**Fail-safe**][**Fail-secure**].

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
2. Maximum Cable Length: [**15 ft (5 m)**][**50 ft (15 m)**][**100 ft (30 m)**]<**Insert cable length**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for electrified locking devices and accessories with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 PROTECTION

A. After installation, protect electrified locking devices and accessories from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.4 MAINTENANCE

A. Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.

    a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00B

SECTION 28 15 00 00C - EGRESS MANAGEMENT DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Magnetic lock hardware with special locking arrangement for non-fire-rated doors.
2. Magnetic lock hardware with special locking arrangement for fire-rated doors.
3. Panic hardware with special locking arrangement for fire-rated doors.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 DEFINITIONS

A. BMS: Building management system.

B. NFC: Near Field Communications.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For egress management devices. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.

4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for egress management devices.
2. Manufacturer's recommended tests and inspections for egress management devices.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to egress management devices, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for egress management devices requiring approval by authorities having jurisdiction must be signed and sealed by qualified professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

B. Submittals for egress management devices require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.8 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with

[**ASIS**]<**Insert organization**> testing standards.

PART 2 - PRODUCTS

2.1 MAGNETIC LOCK HARDWARE WITH SPECIAL LOCKING ARRANGEMENT FOR NON-FIRE-RATED DOORS

A. Description: Magnetic lock connected to access control system and programmed for desired function. Magnetic lock may be programmed for release by access control system. Magnetic lock may also be pressure sensing, programmed to release and alarm after pressure is applied for a designated period.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Camden Door Controls**]
2. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
3. [**Schlage; an Allegion brand**]
4. [**SECO-LARM U.S.A., Inc.**]
5. [**Vanguard Security Engineering Corp. (VGSE)**]
6. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Camden Door Controls**]
2. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
3. [**Schlage; an Allegion brand**]
4. [**SECO-LARM U.S.A., Inc.**]
5. [**Vanguard Security Engineering Corp. (VGSE)**]
6. <**Insert manufacturer's name**>

D. Source Limitations: Obtain products from single manufacturer.

E. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
b. Electromagnetic Locks for Non-Fire-Rated Doors: UL CCN CVYT; including UL 1034.

F. Options:

1. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.

2. Holding Force: [**1200 lbf (5338 N)**]<**Insert force**>.
3. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.
4. Relock Function: [**Manual**][**Delayed automatic**] relock.
5. Door Prop Alarm Delay: [**None**][**30 seconds**]<**Insert delay**>.
6. Door Movement Detection: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].
7. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].

2.2 MAGNETIC LOCK HARDWARE WITH SPECIAL LOCKING ARRANGEMENT FOR FIRE-RATED DOORS

A. Description: Magnetic lock connected to access control system and programmed for desired function. Magnetic lock may be programmed for release by access control system. Magnetic lock may also be pressure sensing, programmed to release and alarm after pressure is applied for a designated period.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
2. [**BEA Americas; Halma plc**]
3. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
4. [**Hager Companies**]
5. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
6. [**SARGENT Manufacturing Company; ASSA ABLOY**]
7. [**Schlage; an Allegion brand**]
8. [**Vanguard Security Engineering Corp. (VGSE)**]
9. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
2. [**BEA Americas; Halma plc**]
3. [**Gianni Electro Magnet (GEM); Gianni Industries, Inc.**]
4. [**Hager Companies**]
5. [**Rutherford Controls Int'l. (RCI); dormakaba Group**]
6. [**SARGENT Manufacturing Company; ASSA ABLOY**]
7. [**Schlage; an Allegion brand**]
8. [**Vanguard Security Engineering Corp. (VGSE)**]
9. <**Insert manufacturer's name**>

D. Source Limitations: Obtain products from single manufacturer.

E. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
b. Electromagnetic Locks for Fire-Rated Doors: UL CCN GWXT; including UL 10B and UL 10C.

F. Options:

1. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.
2. Holding Force: [**1200 lbf (5338 N)**]<**Insert force**>.
3. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.
4. Relock Function: [**Manual**][**Delayed automatic**] relock.
5. Door Prop Alarm Delay: [**None**][**30 seconds**]<**Insert delay**>.
6. Door Movement Detection: [**1/8 inch (3 mm)**][**1/4 inch (6 mm)**][**1/2 inch (13 mm)**][**3/4 inch (19 mm)**][**1 inch (25 mm)**].
7. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].

2.3 PANIC HARDWARE WITH SPECIAL LOCKING ARRANGEMENT FOR FIRE-RATED DOORS

A. Description: This category covers devices mounted on outward-swinging exit doors to facilitate egress. When activated, devices monitor against unauthorized egress and allow exiting after specified time delay. These devices allow immediate exit in case of power failure or upon activation of fire-alarm system.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
2. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
3. [**Detex Corporation**]
4. [**Kaba Mas - LA GARD; dormakaba Group**]
5. [**Von Duprin; Allegion plc**]
6. [**Yale Security Inc; ASSA ABLOY**]
7. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**ASSA ABLOY Electronic Security Hardware; ASSA ABLOY**]
2. [**Corbin Russwin, Inc.; an ASSA ABLOY Group company**]
3. [**Detex Corporation**]
4. [**Kaba Mas - LA GARD; dormakaba Group**]
5. [**Von Duprin; Allegion plc**]
6. [**Yale Security Inc; ASSA ABLOY**]
7. <**Insert manufacturer's name**>

D. Source Limitations: Obtain products from single manufacturer.

E. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory

recognized by authorities having jurisdiction, and marked for intended location and application.
b. Compliant with NFPA 101, ICC IBC, and local life safety code requirements for use along means of egress.

2. Listing Criteria:

a. Special Locking Arrangements: UL CCN FWAX or UL CCN FWAX2; including UL 294, NFPA 101, and ICC IBC.
b. Panic Hardware for Fire-Rated Doors: UL CCN GXHX, UL 10C, and UL 305.
c. Controlled-Exit Panic Devices: UL CCN FULA; including UL 305.

F. Options:

1. Input Voltage: [**12 to 24 V(dc)**]<**Insert voltage**>.
2. Release Delay: [**Zero**][**Five**][**10**][**15**]<**Insert number**> seconds.
3. Door Prop Alarm: [**None**][**Activate after 30 seconds**]<**Insert delay**>.
4. Dry contact for external alarm relay[**to security system**][**to fire-alarm system**][**to BMS**].
5. Secondary Power: [**9 V battery**]<**Insert power source**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF EGRESS MANAGEMENT DEVICES

A. Comply with manufacturer's published instructions.

B. Interfaces with Other Work:

1. Coordinate installation of new products for egress management devices with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Section 282000 "Video Surveillance" for coordination of automatic video feed callup upon delayed egress activation.
3. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC" for monitoring of egress management device alarms by BMS.
4. Coordinate with Section 284600 "Fire Detection and Alarm" for monitoring of egress management device alarms by fire-alarm system.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

END OF SECTION 28 15 00 00C

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SECTION 28 15 00 00D - TELEPHONE ENTRY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Analog audio telephone entry systems.
2. Digital audio-video telephone entry systems.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For telephone entry systems. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Analog audio telephone entry systems.
2. Digital audio-video telephone entry systems.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for telephone entry systems.
2. Manufacturer's recommended tests and inspections for telephone entry systems.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to telephone entry systems, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed telephone entry system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that telephone entry system performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 ANALOG AUDIO TELEPHONE ENTRY SYSTEMS

A. Description: This category covers telephone entry systems, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CellGate**]
2. [**DoorKing, Inc**]
3. [**Viking Electronics, Inc.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CellGate**]
2. [**DoorKing, Inc**]
3. [**Viking Electronics, Inc.**]
4. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.
3. General Characteristics:

a. Minimum Ring Voltage: 25 V(ac rms).
b. Maximum Ring Voltage: 90 V(ac rms).

E. Options:

1. Operating Temperature Range: [**Minus 29 to plus 140 deg F (Minus 34 to plus 60 deg C)**]<**Insert temperature range**>.
2. Speaker Volume: Approximately [**62 dB**][**70 dB**] maximum at 1 m.
3. CPC Disconnect Time: [**300 ms**][**500 ms**] minimum.

4. REN: [**0.5 A**][**0.8 A**].
5. Materials: [**Painted aluminum**][**Stainless steel**]<**Insert material**>.
6. Finishes: [**Brushed stainless steel**][**Oil-rubbed bronze**]<**Insert finish**>.
7. Built-in Reader: [**125 kHz**][**and**][**13.56 MHz**] Wiegand proximity card reader.

    a. Proximity Card Reader Power: 5 to 14 V(dc).
    b. Proximity Card Reader Range: **1-1/4 to 2 inch (32 to 51 mm)**.

8. Mounting: [**Wall**][**Flat-sided post**] mounted.
9. Auto Answer: Selectable.
10. Speed Dial Buttons: [**12**]<**Insert number**>.
11. Keyless Entry Code Capacity: [**50**]<**Insert number**>.
12. Communications: [**VoIP**][**POTS**].
13. Input Power: [**12 to 24 V(ac/dc)**][**Telephone line powered 20 V(dc)**].

F. Accessories:

1. Surface-mount box.
2. Pedestal-mount kit.

2.2 DIGITAL AUDIO-VIDEO TELEPHONE ENTRY SYSTEMS

A. Description: This category covers digital audio-video telephone entry systems, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CellGate**]
2. [**Enterphone; a brand of Identiv, Inc.**]
3. [**Viking Electronics, Inc.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**CellGate**]
2. [**Enterphone; a brand of Identiv, Inc.**]
3. [**Viking Electronics, Inc.**]
4. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.

E. Options:

1. Operating Temperature: [**Minus 4 to plus 130 deg F (Minus 20 to plus 55 deg C)**].
2. Input Power: [**120 V(ac)**][**13.8 V(ac) adapter**][**12 to 24 V(ac/dc)**].
3. Speaker Volume: Approximately [**62 dB**][**70 dB**] maximum at 1 m.

4. CPC Disconnect Time: [**300 ms**][**500 ms**] minimum.
5. REN: [**0.5 A**][**0.8 A**].
6. Materials: [**Painted aluminum**][**Stainless steel**]<**Insert material**>.
7. Finishes: [**Brushed stainless steel**][**Oil-rubbed bronze**]<**Insert finish**>.
8. Built-in Reader: [**125 kHz**][**and**][**13.56 MHz**] Wiegand proximity card reader.

    a. Proximity Card Reader Power: 5 to 14 V(dc).
    b. Proximity Card Reader Range: **1-1/4 to 2 inch (32 to 51 mm)**.

9. Video Camera: Color video camera with wide viewing angle and tilt/swivel adjustments.

    a. Display: [**7 inch (178 mm)**][**11 inch (279 mm)**] full-color[**touchscreen**].
    b. Camera Relay Contact: [**0.5 A at 125 V(ac)**][**1.0 A at 30 V(dc)**].
    c. Camera Power: [**6 to 22 V(dc)**][**12 V(dc) adapter**].
    d. Camera Field of View: [**80**][**90**] degrees.
    e. Camera Tilt/Swivel Adjustment: Vertical plus-or-minus 20 degrees; horizontal plus-or-minus 30 degrees.
    f. Night Vision: [**Infrared Illumination**][**Optical filter**].

10. Mounting: Devices must be [**wall**][**flat-sided post**] mounted.
11. Auto Answer: Selectable.
12. Speed Dial Buttons: [**12**]<**Insert number**>.
13. Keyless Entry Code Capacity: [**50**]<**Insert number**>.

F. Accessories:

1. Surface-mount box.
2. Pedestal-mount kit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
2. Maximum Cable Length: [**1000 ft (300 m)**]<**Insert length**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for telephone entry system with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. System will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

3.4 PROTECTION

A. After installation, protect telephone entry system from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version.

Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00D

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SECTION 28 15 00 00E - INTERCOM ENTRY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital audio intercom entry systems.
2. Digital audio-video intercom entry systems.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For intercom entry system. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Digital audio intercom entry systems.
2. Digital audio-video intercom entry systems.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation and startup instructions for intercom entry systems.
2. Manufacturer's recommended tests and inspections for intercom entry systems.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to intercom entry system, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed intercom entry system perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that intercom entry system perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. [**Initial**]Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 DIGITAL AUDIO INTERCOM ENTRY SYSTEMS

A. Description: This category covers digital audio intercom entry systems, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aiphone Corporation**]
2. [**Stentofon; a brand of Zenitel USA**]
3. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aiphone Corporation**]
2. [**Stentofon; a brand of Zenitel USA**]
3. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.

E. Options:

1. Operating Temperature: [**Minus 29 to plus 150 deg F (Minus 34 to plus 65 deg C)**].
2. Input Power: [**18 to 24 V(dc)**].
3. Connectivity: [**Hardwired**][**Wireless**].
4. Minimum Ring Voltage: 25 V(ac rms).
5. Maximum Ring Voltage: 90 V(ac rms).
6. Speaker Volume: Approximately [**62 dB**][**70 dB**] maximum at 1 m.
7. Materials: [**Painted aluminum**][**Stainless steel**].
8. Finishes: [**Brushed stainless steel**][**Oil-rubbed bronze**][**Satin white**][**Satin black**][**Textured black**].
9. Climate: [**Indoor**][**and**][**outdoor**].

10. Mounting: Devices must be [**wall**][**flat-sided post**][**gooseneck pedestal**][**flush**] mounted.
11. Push-to-talk button.

F. Accessories:

1. [**Surface**][**Recessed**] back box.
2. External keypad.
3. Mounting adaptor plate.
4. Mullion mounting bracket.
5. Desk stand.

2.2 DIGITAL AUDIO-VIDEO INTERCOM ENTRY SYSTEMS

A. Description: This category covers digital audio-video intercom entry systems, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aiphone Corporation**]
2. [**CAME Americas Automation LLC**]
3. [**Enterphone; a brand of Identiv, Inc.**]
4. [**Stentofon; a brand of Zenitel USA**]
5. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aiphone Corporation**]
2. [**CAME Americas Automation LLC**]
3. [**Enterphone; a brand of Identiv, Inc.**]
4. [**Stentofon; a brand of Zenitel USA**]
5. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALVY; including UL 294.

E. Options:

1. Operating Temperature: [**Minus 29 to plus 150 deg F (Minus 34 to plus 65 deg C)**].
2. Input Power: [**18 to 24 V(dc)**].
3. Connectivity: [**Hardwired**][**Wireless**].
4. Minimum Ring Voltage: 25 V(ac rms).
5. Maximum Ring Voltage: 90 V(ac rms).
6. Speaker Volume: Approximately [**62 dB**][**70 dB**] maximum at 1 m.
7. Materials: [**Painted aluminum**][**Stainless steel**].
8. Finishes: [**Brushed stainless steel**][**Oil-rubbed bronze**][**Polished brass**][**Satin white**][**Satin black**].
9. Climate: [**Indoor**][**and**][**outdoor**].

10. Mounting: Devices must be [**wall**][**flat-sided post**][**gooseneck pedestal**] mounted.
11. Video Camera:

    a. Display: [**7 inch (178 mm)**][**11 inch (279 mm)**] full-color[**touchscreen**].
    b. Camera Input Power: [**6 to 22 V(dc)**][**12 V(dc) adapter**].
    c. Camera Field of View: 80 degrees horizontal, 60 degrees vertical, and 100 degrees diagonal.
    d. Camera Tilt/Swivel Adjustment: Vertical plus-or-minus 20 degrees; horizontal plus-or-minus 30 degrees.

F. Accessories:

1. [**Surface**][**Recessed**] back box.
2. External keypad.
3. Mounting adaptor plate.
4. Mullion mounting bracket.
5. Desk stand.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Hardwired System:

    a. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
    b. Maximum Line Loop Cable Length: [**6300 ft (1.9 km)**]<**Insert cable length**>.
    c. Maximum Power-over-Ethernet Cable Length: [**150 ft (50 m)**][**300 ft (100 m)**][**450 ft (150 m)**].

2. Wireless Systems:

    a. Maintain compliance with [**Owner's**][**Project**] wireless standards specified in Division 27.
    b. <**Insert requirement**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for intercom entry systems with existing conditions.

    a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Division 27 for wireless network provisioning of wireless intercom entry systems.

D. Wireless Security:

1. IP Security:

    a. Hardware Root of Trust.
    b. SSH.
    c. HTTPS.

d. Firewall.

2. Software Integrity Check: [**SHA256**]<**Insert type**>.
3. Access to system management is restricted via a separate interface.
4. Smartphone Interface: [**Enable**][**Disable**] smartphone connectivity.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. System will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 SYSTEM STARTUP

A. [**Engage a factory-authorized service representative to perform**][**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

3.4 PROTECTION

A. After installation, protect intercom entry system from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

    a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00E

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SECTION 28 15 00 00F - ELECTRONIC KEY MANAGEMENT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Key management system units.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For key management systems. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Key management system units.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. System mounting details.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for key management systems.
2. Manufacturer's recommended tests and inspections for key management systems.

1.5 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

PART 2 - PRODUCTS

2.1 KEY MANAGEMENT SYSTEM UNITS

A. Description: This category covers units for key management systems providing a means of regulating or controlling keys by electrical, electronic and/or mechanical means. Key management systems allow authorized users access to keys upon verification of appropriate credentials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ALZK; including UL 294.

C. Electronic Key Management System Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**MATRIX Cabinet**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**MATRIX Cabinet**]
d. <**Insert manufacturer's name**>

3. Options:

a. Input Voltage: [**110 to 240 V(ac)**]<**Insert voltage**>.
b. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
c. Key Storage Capacity: <**Insert number**>.
d. Operating Frequency: [**125 kHz**][**13.56 MHz**].
e. Materials: [**Stainless steel**]<**Insert material**>.
f. Finishes: [**Powder coated**]<**Insert finish**>.
g. Backup Battery: [**12 V(dc)**]<**Insert battery size**>.
h. Front Cover: [**Clear display window**][**Solid panel**].
i. Enclosure Size: <**Insert size**>.

4. Operation:

a. Access Method: [**Proximity card**][**and**][**biometrics**][**and**][**keypad**][**and**][**standard key**].
b. Alarm Output: [**Local sounder**][**Output contacts**].

D. Mechanical Key Management System Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**XceedID; an Allegion brand**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Deister Electronic USA, Inc.**]
b. [**KEYper Systems; Marcon International, Inc.**]
c. [**XceedID; an Allegion brand**]
d. <**Insert manufacturer's name**>

3. Options:

a. Key Storage Capacity: <**Insert number**>.
b. Materials: [**Stainless steel**]<**Insert material**>.
c. Finishes: [**Powder coated**]<**Insert finish**>.
d. Front Cover: [**Clear display window**][**Solid panel**].
e. Enclosure Size: <**Insert size**>.

4. Accessories:

a. Mirror hangers.
b. Tamper deals.
c. Key plugs.

d. Access pegs.
e. Key connectors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Interfaces with Other Work:

1. Coordinate installation of new products for key management system units with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 PROTECTION

A. After installation, protect key management system units from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 28 15 00 00F

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SECTION 28 15 00 00G - ACCESS CONTROL ELECTRONIC TURNSTILES AND MOBILITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Turnstile operators with access control devices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For electronic turnstiles. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Certificates:

1. <**Insert certificate requirement**>.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for electronic turnstiles.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Maintenance service agreement.
2. Software and firmware service agreement.

B. Warranty documentation.

1.6 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed turnstile operators with access control devices perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that turnstile operators with access control devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 TURNSTILE OPERATORS WITH ACCESS CONTROL DEVICES

A. Description: This category covers electrical and pneumatic turnstile operators, together with controls and accessories for use with such operators, and similar devices.

B. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aeroturn**]
2. [**Gunnebo; Gunnebo Group**]
3. [**Orion Entrance Control, Inc.**]
4. <**Insert manufacturer's name**>

C. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Aeroturn**]
2. [**Gunnebo; Gunnebo Group**]
3. [**Orion Entrance Control, Inc.**]
4. <**Insert manufacturer's name**>

D. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with the United States Access Board's ADA-ABA Accessibility Guidelines, NFPA 101, and accessibility requirements enforced by authorities having jurisdiction.

2. Listing Criteria:

a. Turnstile Operators: UL CCN FDDR; including UL 325.
b. Access Control Devices: UL CCN ALVY; including UL 294.

3. General Characteristics:

a. Access Control System Integration: Integrated with access control system to grant or deny access to facility.
b. Accessibility: Coordinated[**with Architect**] to accommodate accessibility requirements where required.
c. Key Override: Manual key emergency open override available at turnstile cabinet.

d. Climb-over Detection: Sensors detect attempts to circumvent turnstile by climbing or jumping over, activating local alarm.

E. Options:

1. Capable of using [**flush-**][**or**][**surface-**]mounted readers.
2. Reader Mounting Location: [**Top**][**Front**][**Side**].
3. Directional Control: [**Allow free egress**][**Prohibit passage**] in direction opposite of credential reading.
4. Odometer: Passageway odometer is to be [**internally**][**or**][**remotely**] mounted.
5. Locking: Normally locked in the [**egress**][**and**][**ingress**] directions.
6. Operating Element: [**Drop arm**][**Rotary tripod**][**Full-height glazed portal**][**Partial-height glazed portal**].
7. Mounting: Devices must be [**floor**][**wall**][**ceiling**] mounted.
8. Finishes:

a. Stainless steel.
b. Galvanized painted steel.
c. Cast aluminum with painted gray finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL ELECTRONIC TURNSTILES AND MOBILITY SYSTEMS

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable type**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for turnstile operator with access control device with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with Division 02[**and Division 03**] to perform cutting/drilling of existing floor slab for installation of electronic turnstiles.
3. Coordinate with Division 26 to provide power to electronic turnstiles.
4. Coordinate with Section 284600 "Fire Detection and Alarm" to interface fire-alarm control circuit with turnstiles to automatically open upon alarm activation.

3.2 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and

inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for turnstile operator and access control device.

E. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

3.3 PROTECTION

A. After installation, protect turnstile operators and access control devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.4 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three**][**six**][**nine**][**12**] months' full maintenance by [**skilled employees of turnstile operator with access control device Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper turnstile operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

B. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.[**Verify that upgrading software includes**

operating system and new or revised licenses for using software.]

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 00 00G

Task	Specification	Specification Description
28 15 00 00	28 10 00 00	Access Control
28 15 00 00	28 10 00 00a	Access Control Software and Database Management
28 15 00 00	28 10 00 00b	Access Control System Hardware

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SECTION 28 15 11 00 - INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Credential readers.
2. Keypads.
3. Biometric identity devices.
4. Combination reader devices.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Owner-Furnished Products" Article, "Existing Products to be Modified" Article, or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281513 "Access Control Credentials" for credential products for use with reader devices.

1.2 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.3 DEFINITIONS

A. PoE: Power over Ethernet.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For integrated credential readers and entry management systems. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, [**Owner's security representatives,**][**IT representatives,**] and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.5 ACTION SUBMITTALS

A. Product Data: For each product type.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.
2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Sustainable Design Submittals:

1. Product data for sustainable design features for each type of product.

D. Field quality-control reports.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Installation instructions for integrated credential readers and entry management devices.
2. Inspection and testing recommendations for integrated credential readers and entry management devices.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for firmware upgrades.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Firmware service agreement.

B. Warranty documentation.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra stock material.

B. Special tools.

1.9 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.10 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor**>.

B. Description: <**Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation**>.

C. Accessories: <**Insert accessories that will be provided with product**>.

2.2 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

1. Sustainable Design Features:

    a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact Work**>.

1. Sustainable Design Features:

    a. Material Reuse: Product is salvaged, refurbished, or reused.

C. Accessories: <**Insert accessories included with existing product**>.

2.4 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.5 CREDENTIAL READERS

A. Description: Electronic devices that read one or more types of access credentials and are part of overall access control system. These devices read and transfer credential info to access control system for control of door locks and other access control components.

B. Swipe Card Reader :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**aptiQ; an Allegion brand**]
    b. [**Cansec Systems Ltd.**]
    c. [**HID Global; ASSA ABLOY**]
    d. [**Peripheral Dynamics, Inc.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**aptiQ; an Allegion brand**]
    b. [**Cansec Systems Ltd.**]
    c. [**HID Global; ASSA ABLOY**]

d. [**Peripheral Dynamics, Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Visual LED indication of credential authorization.
   b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   c. Input Voltage: [**5 to 12 V(dc)**]<**Insert power input**>.
   d. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
   e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   f. Colors: [**Black**][**Gray**]<**Insert color**>.
   g. Climate: [**Indoor**][**and**][**outdoor**].
   h. Size: [**Single gang**][**or**][**double gang**].

C. Chip Card Reader :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**HID Global; ASSA ABLOY**]
   b. [**Hirsch; a brand of Identiv, Inc.**]
   c. [**XceedID; an Allegion brand**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**HID Global; ASSA ABLOY**]
   b. [**Hirsch; a brand of Identiv, Inc.**]
   c. [**XceedID; an Allegion brand**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of credential authorization.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Voltage: [**5 to 12 V(dc)**]<**Insert power input**>.
d. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Size: [**Single gang**][**or**][**double gang**].

D. Proximity Reader for Card, Fob, or Smartphone :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AMAG Technology; G4S USA**]
   b. [**aptiQ; an Allegion brand**]
   c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   d. [**HID Global; ASSA ABLOY**]
   e. [**IDenticard Systems; Precision Dynamics Corporation**]
   f. [**Openpath Security, Inc.**]
   g. [**Suprema Inc.**]
   h. [**XceedID; an Allegion brand**]
   i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AMAG Technology; G4S USA**]
   b. [**aptiQ; an Allegion brand**]
   c. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   d. [**HID Global; ASSA ABLOY**]
   e. [**IDenticard Systems; Precision Dynamics Corporation**]
   f. [**Openpath Security, Inc.**]
   g. [**Suprema Inc.**]
   h. [**XceedID; an Allegion brand**]
   i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Visual LED indication of credential authorization.
   b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   c. Input Voltage: [**5 to 16 V(dc)**][**PoE**]<**Insert power input**>.

d. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
e. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**].
f. Transmit Frequency: [**125 kHz**][**13.56 MHz**][**2.4 GHz**].
g. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
h. Colors: [**Black**][**Gray**]<**Insert color**>.
i. Climate: [**Indoor**][**and**][**outdoor**].
j. Size: [**Single gang**][**or**][**double gang**].

6. Accessories:

a. Long-range receiver module.

E. Proximity Card Reader for Hazardous (Classified) Location :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**HID Global; ASSA ABLOY**]
b. [**XceedID; an Allegion brand**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**HID Global; ASSA ABLOY**]
b. [**XceedID; an Allegion brand**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.
c. Additional Listing Criteria:

1) UL CCN AATF; including UL 294.
2) UL CCN AAIZ for NFPA 70 Class I, Division 1, Group[**A**][**B**][**C**][**D**] hazardous locations; including NFPA 496, UL 1203, UL 913, or UL 60079-28.
3) UL CCN AAIZ for NFPA 70 Class I, Division 2, Group[**A**][**B**][**C**][**D**] hazardous locations; including NFPA 496, UL 121201, or UL 60079-28.
4) UL CCN AAIZ for NFPA 70 Class II, Division 1, Group[**E**][**F**][**G**] hazardous locations; including NFPA 496, UL 1203, UL 913, or UL 60079-28.
5) UL CCN AAIZ for NFPA 70 Class II, Division 2, Group[**F**][**G**] hazardous locations; including NFPA 496, UL 121201, or UL 60079-28.
6) UL CCN AAIZ for NFPA 70 Class III, Division 1 hazardous locations; including UL 913 or UL 121201.
7) UL CCN AAIZ for NFPA 70 Class III, Division 2 hazardous locations; including UL 913 or UL 121201.

5. Standard Features:

    a. Visual LED indication of credential authorization.
    b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
    c. Input Voltage: [**5 to 16 V(dc)**]<**Insert power input**>.
    d. Operating Temperature: [**Minus 40 to plus 160 deg F (Minus 40 to plus 71 deg C)**]<**Insert temperature**>.
    e. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**][**5 inch (127 mm)**].
    f. Transmit Frequency: [**125 kHz**][**2.4 GHz**].
    g. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
    h. Colors: [**Black**][**Gray**]<**Insert color**>.
    i. Climate: [**Indoor**][**and**][**outdoor**].
    j. Size: [**Single gang**][**or**][**double gang**].

2.6 KEYPADS

A. Description: Electronic devices with[**numerical**] keypads for keyless entry.

B. Door Lock Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alarm Lock; NAPCO Security Technologies, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alarm Lock; NAPCO Security Technologies, Inc.**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

    a. UL CCN ALVY; including UL 294.
    b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

    a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
    b. Visual LED indication of [**three-**][**or**][**six-**]digit code read.
    c. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**][**Alkaline batteries**]<**Insert power input**>.
    d. Operating Temperature: [**Minus 20 to plus 150 deg F (Minus 29 to plus 66 deg C)**]<**Insert temperature**>.
    e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
    f. Colors: [**Black**][**Gray**]<**Insert color**>.
    g. Climate: [**Indoor**][**and**][**outdoor**].

h. Size: [**Single gang**][**or**][**double gang**].
i. Mounting:

1) Door/window mullions.
2) Outlet boxes.
3) Flat surfaces.
4) Integrated door lock keypad.

C. LCD Alarm Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Open Options; ACRE, LLC**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Open Options; ACRE, LLC**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of code read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**]<**Insert power input**>.
d. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**][**White**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Mounting:

1) Surface mount.
2) Triple-gang outlet box.

D. Scramble Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Hirsch; a brand of Identiv, Inc.**]

b. [**Schlage; an Allegion brand**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hirsch; a brand of Identiv, Inc.**]
b. [**Schlage; an Allegion brand**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
b. Visual LED indication of [**three-**][**or**][**six-**][**or**][**nine-**]digit code read.
c. Input Power: [**8 to 12 V(dc)**]<**Insert power input**>.
d. Operating Temperature: [**5 to 122 deg F (Minus 15 to plus 50 deg C)**]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Mounting: [**Single-gang**][**or**][**double-gang**] outlet box.

2.7 BIOMETRIC IDENTITY DEVICES

A. Description: Electronic devices that read biometrics information, including fingerprint, palm, iris and facial characteristics. These devices read and transfer credential info to the access control system for control of door locks and other access control components.

B. Single Finger Scanners :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**IDTECK Global, Inc.**]
d. [**Suprema Inc.**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**IDTECK Global, Inc.**]
d. [**Suprema Inc.**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of fingerprint read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**5 to 12 V(dc)**][**5 V(dc)**][**12 V(dc)**][**PoE**][**Alkaline battery**]<**Insert power input**>.
d. Operating Temperature: [**5 to 122 deg F (Minus 15 to plus 50 deg C)**]<**Insert temperature**>.
e. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**][**4 inch (102 mm)**].
f. Transmit Frequency: [**125 kHz**][**13.56 MHz**].
g. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
h. Colors: [**Black**][**Gray**]<**Insert color**>.
i. Climate: [**Indoor**][**and**][**outdoor**].
j. Mounting: [**Single-gang**][**or**][**double-gang**] outlet box.

C. Palm Scanner :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fujitsu**]
b. [**IDEMIA; Oberthur Technologies and Safran Identity & Security**]
c. [**iDentityTech Solutions, Ltd.**]
d. [**Schlage; an Allegion brand**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fujitsu**]
b. [**IDEMIA; Oberthur Technologies and Safran Identity & Security**]
c. [**iDentityTech Solutions, Ltd.**]
d. [**Schlage; an Allegion brand**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical**

testing laboratory recognized by authorities having jurisdiction] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of palm read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**8 to 12 V(dc)**][**PoE**][**Alkaline battery**]<**Insert power input**>.
d. Operating Temperature: [**14 to 131 deg F (Minus 10 to plus 55 deg C)**]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Mounting:

1) Surface mount.
2) [**Single-gang**][**or**][**double-gang**] outlet box.

D. Iris Scanner :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**EyeLock, LLC; VOXX International Corporation**]
b. [**Iris ID Systems, Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**EyeLock, LLC; VOXX International Corporation**]
b. [**Iris ID Systems, Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual indication of iris read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**12 to 24 V(dc)**][**5 V(dc)**]<**Insert power input**>.
d. Operating Temperature: [**32 to 113 deg F (0 to 45 deg C)**]<**Insert temperature**>.

e. Scan Range: [8 inch (203 mm)][11 to 15 inch (279 to 381 mm)]<**Insert scan range**>.
f. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
g. Colors: [**Black**][**Gray**]<**Insert color**>.
h. Climate: [**Indoor**][**and**][**outdoor**].
i. Mounting:

1) Surface mount.
2) [**Single-gang**][**or**][**double-gang**] outlet box.

E. Facial Scanner :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**IDEMIA; Oberthur Technologies and Safran Identity & Security**]
b. [**Suprema Inc.**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**IDEMIA; Oberthur Technologies and Safran Identity & Security**]
b. [**Suprema Inc.**]
c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual display indication of facial read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**12 to 24 V(dc)**][**PoE**]<**Insert power input**>.
d. Operating Temperature: [41 to 113 deg F (5 to 45 deg C)]<**Insert temperature**>.
e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
f. Colors: [**Black**][**Gray**]<**Insert color**>.
g. Climate: [**Indoor**][**and**][**outdoor**].
h. Mounting:

1) Stand up.
2) Desktop.

2.8 COMBINATION READER DEVICES

A. Description: Electronic devices that read credentials via a combination of swipe or proximity card readers, keypads, and biometrics scanners. These devices read and transfer credential info to the

access control system for control of door locks and other access control components.

B. Combination Card Reader and Keypad :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   b. [**Hirsch; a brand of Identiv, Inc.**]
   c. [**Open Options; ACRE, LLC**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Farpointe Data Inc.; DORMA USA, Inc.; dormakaba Group**]
   b. [**Hirsch; a brand of Identiv, Inc.**]
   c. [**Open Options; ACRE, LLC**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

   a. UL CCN ALVY; including UL 294.
   b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

   a. Visual LED indication of code and/or card read.
   b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
   c. Input Power: [**5 to 16 V(dc)**][**12 to 28 V(dc)**]<**Insert power input**>.
   d. Operating Temperature: [**32 to 122 deg F (0 to 50 deg C)**]<**Insert temperature**>.
   e. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
   f. Colors: [**Black**][**Gray**][**White**]<**Insert color**>.
   g. Climate: [**Indoor**][**and**][**outdoor**].
   h. Mounting:

      1) Surface mount.
      2) Triple-gang wall box.

C. Combination Card Reader/Keypad and Biometrics Scanner :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cansec Systems Ltd.**]
   b. [**HID Global; ASSA ABLOY**]

c. [**IDTECK Global, Inc.**]
d. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cansec Systems Ltd.**]
b. [**HID Global; ASSA ABLOY**]
c. [**IDTECK Global, Inc.**]
d. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by [**UL Solutions**][**or**][**FM Approvals**][**, CSA Group (with "US" marking)**][**, Intertek ETL**][**, TÜV Rheinland**][**, or other qualified electrical testing laboratory recognized by authorities having jurisdiction**] in accordance with one or more of the following guide information and corresponding standards:

a. UL CCN ALVY; including UL 294.
b. Plastic Enclosure: UL CCN QMFZ2; including UL 94.

5. Standard Features:

a. Visual LED indication of fingerprint and/or card read.
b. Enclosure Rating: IEC 60529, [**IP55**][**IP65**][**IP66**]<**Insert IP rating**>.
c. Input Power: [**9 to 24 V(dc)**][**PoE**][**Lithium ion chargeable battery**]<**Insert power input**>.
d. Operating Temperature: [**32 to 104 deg F (0 to 40 deg C)**]<**Insert temperature**>.
e. Read Range: Up to [**1 inch (25 mm)**][**2 inch (51 mm)**][**3 inch (76 mm)**][**4 inch (102 mm)**].
f. Transmit Frequency: [**125 kHz**][**13.56 MHz**].
g. Materials: [**Long-wearing polymeric plastic**][**Polycarbonate**][**Metal**].
h. Colors: [**Black**][**Gray**]<**Insert color**>.
i. Climate: [**Indoor**][**and**][**outdoor**].
j. Mounting:

1) Surface mount.
2) [**Single-gang**][**or**][**double-gang**] wall box.

2.9 MAINTENANCE MATERIAL ITEMS

A. Extra Stock Material: Furnish to Owner extra materials[**, from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.[**Include the following:**]

1. Integrated Credential Readers and Entry Management Devices: [**One**]<**Insert number**> of each type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to integrated credential readers and entry management devices, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. <**Insert item**>.

PART 3 - EXECUTION

3.1 INSTALLATION OF INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: [**Shielded**][**Unshielded**]<**Insert cable size**>.
2. Maximum Cable Length: [**300 ft (100 m)**][**500 ft (150 m)**]<**Insert cable length**>.

C. Interfaces with Other Work:

1. Coordinate installation of new products for integrated credential readers and entry management devices with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

2. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

3.2 FIELD QUALITY CONTROL OF INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>. [**Testing of devices along means of egress must be witnessed by authorities having jurisdiction.**]

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for the following:

a. Credential readers.
b. Keypads.
c. Biometric identity devices.
d. Combination reader devices.

E. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.3 PROTECTION

A. After installation, protect integrated credential readers and entry management devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.4 MAINTENANCE

A. Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two**]<**Insert number**> years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two**]<**Insert number**> years from date of Substantial Completion.

a. Upgrade Notice: No fewer than [**30**]<**Insert number**> days to allow Owner to schedule and access the system.

3. Field Reports for Firmware Upgrades: Prepare report after each update, documenting upgrades installed.

END OF SECTION 28 15 11 00

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Task	Specification	Specification Description
28 15 11 00	28 10 00 00	Access Control
28 15 11 00	28 10 00 00a	Access Control Software and Database Management
28 15 11 00	28 10 00 00b	Access Control System Hardware
28 15 11 00	28 15 00 00	Integrated Access Control Hardware Devices
28 15 11 00	28 15 00 00a	Access Control Credentials
28 15 11 00	28 15 00 00b	Electrified Locking Devices and Accessories
28 15 11 00	28 15 00 00c	Egress Management Devices
28 15 11 00	28 15 00 00d	Telephone Entry Systems
28 15 11 00	28 15 00 00e	Intercom Entry Systems
28 15 11 00	28 15 00 00f	Electronic Key Management Systems
28 15 11 00	28 15 00 00g	Access Control Electronic Turnstiles and Mobility Systems
28 15 11 13	28 10 00 00	Access Control
28 15 11 13	28 10 00 00a	Access Control Software and Database Management
28 15 11 13	28 10 00 00b	Access Control System Hardware
28 15 11 13	28 15 00 00	Integrated Access Control Hardware Devices
28 15 11 13	28 15 11 00	Integrated Credential Readers and Entry Management
28 15 11 13	28 15 00 00a	Access Control Credentials
28 15 11 13	28 15 00 00b	Electrified Locking Devices and Accessories
28 15 11 13	28 15 00 00c	Egress Management Devices
28 15 11 13	28 15 00 00d	Telephone Entry Systems
28 15 11 13	28 15 00 00e	Intercom Entry Systems
28 15 11 13	28 15 00 00f	Electronic Key Management Systems
28 15 11 13	28 15 00 00g	Access Control Electronic Turnstiles and Mobility Systems
28 16 00 00	28 10 00 00	Access Control
28 16 00 00	28 10 00 00a	Access Control Software and Database Management
28 16 00 00	28 10 00 00b	Access Control System Hardware

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SECTION 28 16 11 00 - INTRUSION DETECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sensing devices.
2. Control devices.
3. Notification devices.
4. Security fasteners.

B. Related Sections:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for power cabling between master control units and field-mounted devices and control units.
5. Section 271313 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.
6. Section 271323 "Communications Optical Fiber Backbone Cabling" for multi- and single-mode backbone (riser-rated) optical fiber.
7. Section 271513 "Communications Copper Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.
8. Section 271523 "Communications Optical Fiber Horizontal Cabling" for multi- and single-mode horizontal (general use, riser-, and plenum-rated) optical fiber.
9. Section 281300 "Access Control System Software and Database Management" for applications, interfaces, and workstations.
10. Section 283121 "Area and Perimeter Intrusion Detection" for outdoor intrusion detection devices, including lighting and communications associated with chain-link fence gates.
11. Section 282000 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.

1.2 DEFINITIONS

A. CCTV: Closed-circuit television.

B. PIR: Passive infrared.

C. RFI: Radio-frequency interference.

D. UPS: Uninterruptible power supply.

E. Control Unit: System component that monitors inputs and controls outputs through various circuits.

F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

I. Standard Intruder: A person who weighs **100 lb (45 kg)** or less and whose height is **60 inch (1525 mm)** or less; dressed in a long-sleeved shirt, slacks, and shoes[**unless environmental conditions at the site require protective clothing**].

J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify [**programmable logic controllers**][**networks**][**and**] control interface devices and media to be used. Describe characteristics of network and other data communication lines.

a. Indicate methods used to achieve systems integration.
b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
c. Describe characteristics of network and other data communication lines.
d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection[**and for systems integration**]. Include designation of devices connected by raceway, raceway type and size, and

type and size of wire and cable fill for each raceway run.
3. UPS: Sizing calculations.
4. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.[**Include room layout for master control-unit console, terminal cabinet, racks, and UPS.**]
5. Master Control-Unit Console Layout: Show required artwork and device identification.
6. Device Address List: Coordinate with final system programming.
7. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
8. Details of surge-protection devices and their installation.
9. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required.

F. Field quality-control reports.

1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: In addition to qualification data specified in Section 260010 "Supplemental Requirements for Electrical" submit qualification data for [**Installer**][**intrusion detection systems integrator**][**testing agency**].

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field Test Plans: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within [**60 days**]<**Insert number**> of date of Contract award.
3. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Intrusion Detection Devices: Furnish quantity equal to [**five**]<**Insert number**> percent of the number of units of each type installed, but no fewer than one of each type.
2. Fuses: [**Three**]<**Insert number**> of each kind and size.
3. Tool Kit: Provide [**six**]<**Insert number**> sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
4. Security Fasteners: Furnish no fewer than [**1 box for every 50**]<**Insert numbers**> boxes or fraction thereof, of each type and size of security fastener installed.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS International) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

C. Intrusion Detection Systems Installer:

1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Layout Responsibility: Preparation of Shop Drawings[**and cabling administration Drawings**][**, cabling administration Drawings, and field testing program development**] by [**an RCDD**][**a Technician**].
4. Installation Supervision: Installation must be under the direct supervision of [**Technician**][**Level 2 Commercial Installer**], who must be present at all times when Work of this Section is performed at Project site.

D. Intrusion Detection Systems Integrator: An experienced intrusion detection equipment supplier[**and Installer**] who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

1. At least one of whom is a Certified Systems Integrator.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the requirements specified in Section 018116 "Facility Environmental Requirements" and the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to [**4000 ft (1220 m)**]<**Insert elevation**>.
2. Master Control Unit: Rated for continuous operation in an ambient of **60 to 85 deg F (16 to 29**

deg C) and a relative humidity of 20 to 80 percent, noncondensing.

3. Interior, Controlled Environment: System components, except master control unit, installed in [**air-conditioned**][**temperature-controlled**] interior environments must be rated for continuous operation in ambients of [**36 to 122 deg F (2 to 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Interior, Uncontrolled Environment: System components installed in [**non-air-conditioned**][**non-temperature-controlled**] interior environments must be rated for continuous operation in ambients of [**0 to 122 deg F (minus 18 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
5. Exterior Environment: System components installed in locations exposed to weather must be rated for continuous operation in ambients of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in UL 50E, winds up to [**85 mph (137 km/h)**][**and snow cover up to 24 inch (610 mm) thick**].
6. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings must be rated, listed, and installed according to NFPA 70.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. System Description: [**Hardwired**][**Multiplexed**], modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

1. Supervision: System components must be continuously monitored for normal, alarm, [**supervisory,**]and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

    a. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
    b. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal must indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
    c. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

2. System Control:

    a. Master control unit must directly monitor intrusion detection units and connecting wiring.
    b. Master control unit must directly monitor intrusion detection devices[**, perimeter detection units,**][**, control units associated with perimeter detection units,**] and connecting wiring in a multiplexed distributed control system or as part of a network.

3. System must automatically reboot program without error or loss of status or alarm data after any system disturbance.
4. Operator Commands:

    a. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, must produce a short explanation of the purpose, use, and system reaction to that command.
    b. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
    c. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
    d. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
    e. Protected Zone Test: Initiate operational test of a specific protected zone.
    f. System Test: Initiate system-wide operational test.
    g. Print reports.

5. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
6. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:

    a. Switch selected lights.
    b. Shift elevator control to a different mode.
    c. Open a signal path between certain intercommunication stations.
    d. Shift sound system to "listening mode" and open a signal path to certain system speakers.
    e. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
    f. <**Insert description of automatic control required**>.

7. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands must initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
8. Response Time: [**Two**]<**Insert number**> seconds between actuation of any alarm and its indication at master control unit.
9. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
10. Programmed Secure-Access Control: System must be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations must override programmed settings.
11. Manual Secure-Access Control: Coded entries at manual stations must change status of associated protected zone between secure and access conditions.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria."

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

D. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit must be selected and configured with accessories for full compatibility with the following equipment:

1. Door hardware specified in Section 087100 "Door Hardware."
2. Door hardware specified in Section 087111 "Door Hardware (Descriptive Specification)."
3. Elevators specified in Section 142100 "Electric Traction Elevators."
4. Elevators specified in Section 142400 "Hydraulic Elevators."
5. Lighting controls specified in Section 260923 "Lighting Control Devices."
6. Lighting controls specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."
7. Intercom and program systems specified in Section 275123.20 "Commercial Intercommunications and Program Systems."
8. Intercom and program systems specified in Section 275123.50 "Educational Intercommunications and Program Systems."
9. Public address and mass notification systems specified in Section 275116 "Public Address Systems."
10. Access control system specified in Section 281300 "Access Control System Software and Database Management."
11. Fire alarm system specified in Section 284600 "Fire Detection and Alarm."
12. Mass notification system specified in Section 284700 "Mass Notification."
13. Perimeter security system specified in Section 283121 "Area and Perimeter Intrusion Detection."
14. Video surveillance system specified in Section 282000 "Video Surveillance."
15. <**Insert system or equipment**> specified in Section <**Insert Section number**> "<**Insert Section title**>."

E. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

F. Interference Protection: Components must be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10 000 MHz and conducted interference signals up to 0.25 V(rms) injected into power supply lines at 10 to 10 000 MHz.

G. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components must initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display must identify tamper alarms and indicate locations.

H. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to

verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

I. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

J. Addressable Devices: Transmitter and receivers must communicate unique device identification and status reports to master control unit.

K. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

L. Enclosures:

1. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
2. Interior Electronics: UL 50E, Type 12.
3. Exterior Electronics: UL 50E, Type 4X, [**fiberglass**][**stainless steel**].
4. Corrosion Resistant: UL 50E, Type 4X, [**PVC**][**stainless steel**].
5. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

M. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

2.2 SENSING DEVICES

A. Flush-Mounted Door or Window Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**George Risk Industries**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Interlogix; Carrier Global Corporation**]
f. [**Optex Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**George Risk Industries**]

c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Interlogix; Carrier Global Corporation**]
f. [**Optex Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity.
b. Bias magnet and minimum of [**two**][**three**] encapsulated reed switches must resist compromise from introduction of foreign magnetic fields.
c. Unobtrusive and flush with surface of door or window frame.
d. Remote Test: Simulate movement of actuating magnet from master control unit.

B. Overhead Door Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**George Risk Industries**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Interlogix; Carrier Global Corporation**]
f. [**Optex Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**George Risk Industries**]
c. [**Honeywell Commercial Security; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Interlogix; Carrier Global Corporation**]
f. [**Optex Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. <**Insert manufacturer's name**>

3. Listing Criteria: Listed and labeled for outdoor locations.
4. Standard Features:

a. Balanced-magnetic switch, complying with UL 634, installed on frame with integral

overcurrent device to limit current to 80 percent of switch capacity.
b. Bias magnet and minimum of [**two**][**three**] encapsulated reed switches must resist compromise from introduction of foreign magnetic fields.
c. Has door-mounted magnet and floor-mounted switch unit.
d. Remote Test: Simulate movement of actuating magnet from master control unit.

C. Wall-Mounted PIR Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**Bosch Security Systems, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**Digital Security Controls Ltd.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**Bosch Security Systems, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**Digital Security Controls Ltd.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA PIR-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
b. Maximum Detection Range: 125 percent of indicated distance for individual units and not less than **50 ft (15 m)**.[**Provide adjustable coverage pattern as indicated.**]
c. Sensitivity: Adjustable pattern coverage to detect a change in temperature of **2 deg F (1 deg C)** or less, and standard-intruder movement within sensor's detection patterns at any speed between **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)** across two adjacent segments of detector's field of view.
d. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator must light when sensor detects an intruder. Locate test enabling switch under

sensor housing cover.

e. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

D. Ceiling-Mounted PIR Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aleph America Corporation**]
   b. [**Bosch Security Systems, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**Digital Security Controls Ltd.**]
   e. [**Honeywell International Inc.**]
   f. [**Interlogix; Carrier Global Corporation**]
   g. [**Visonic Inc**]
   h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aleph America Corporation**]
   b. [**Bosch Security Systems, Inc.**]
   c. [**Crow Electronic Engineering, Inc**]
   d. [**Digital Security Controls Ltd.**]
   e. [**Honeywell International Inc.**]
   f. [**Interlogix; Carrier Global Corporation**]
   g. [**Visonic Inc**]
   h. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. Listed and labeled by a qualified electrical testing agency for compliance with SIA PIR-01.
   d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
   b. Spot-Detection Pattern: Full 360-degree conical.
   c. Pattern Size: **84 inch (2135 mm)** diameter at floor level for units mounted **96 inch (2440 mm)** above floor; **18 ft (5.5 m)** diameter at floor level for units mounted **25 ft (7.6 m)** above floor.
   d. Sensitivity: Adjustable pattern coverage to detect a change in temperature of **2 deg F (1 deg C)** or less, and standard-intruder movement within sensor's detection patterns at any speed between **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)** across two adjacent segments of detector's field of view.
   e. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator must light when sensor detects an intruder. Locate test enabling switch under

sensor housing cover.

f. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

E. Microwave Intrusion Detector (Interior) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Crow Electronic Engineering, Inc**]
   c. [**Digital Security Controls Ltd.**]
   d. [**Interlogix; Carrier Global Corporation**]
   e. [**Visonic Inc**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Bosch Security Systems, Inc.**]
   b. [**Crow Electronic Engineering, Inc**]
   c. [**Digital Security Controls Ltd.**]
   d. [**Interlogix; Carrier Global Corporation**]
   e. [**Visonic Inc**]
   f. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
   b. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)**. Sensor sensitivity adjustments must be accessible only when sensor housing is removed, and sensors must comply with 47 CFR 15.
   c. Activation Indicator: LED indicator must not be visible during normal operation. Indicator must light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
   d. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

F. Acoustic-Type, Glass-Break Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Crow Electronic Engineering, Inc**]
b. [**Digital Security Controls Ltd.**]
c. [**Honeywell International Inc.**]
d. [**Interlogix; Carrier Global Corporation**]
e. [**International Electronics, Inc.**]
f. [**Potter Electric Signal Company, LLC**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Crow Electronic Engineering, Inc**]
b. [**Digital Security Controls Ltd.**]
c. [**Honeywell International Inc.**]
d. [**Interlogix; Carrier Global Corporation**]
e. [**International Electronics, Inc.**]
f. [**Potter Electric Signal Company, LLC**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA GB-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Detect unique, airborne acoustic energy spectrum caused by breaking glass.
b. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern must have at least a **20 ft (6 m)** range.
c. Hookup Cable: Factory installed, not less than **72 inch (1830 mm)**.
d. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit[**or at master control unit**].
e. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
f. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

G. Piezoelectric-Type, Glass-Break Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Honeywell International Inc.**]

b. [**Interlogix; Carrier Global Corporation**]
c. [**Potter Electric Signal Company, LLC**]
d. [**Visonic Inc**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell International Inc.**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Potter Electric Signal Company, LLC**]
d. [**Visonic Inc**]
e. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA GB-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Detect unique, high-frequency vibrations caused by breaking glass.
b. Sensor Element: Piezoelectric crystals in a housing designed to mount directly to glass surface with adhesive provided by element manufacturer.
c. Circular detection pattern, with at least a **60 inch (1525 mm)** radius on a continuous glass pane. Sensor element may not have an area larger than **4 inch2 (25.80 cm2)**.
d. Hookup Cable: Factory installed, not less than **72 inch (1830 mm)**.
e. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit[**or at master control unit**].
f. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
g. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

H. Vibration Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Honeywell International Inc.**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Potter Electric Signal Company, LLC**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell International Inc.**]

b. [**Interlogix; Carrier Global Corporation**]
c. [**Potter Electric Signal Company, LLC**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA GB-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. A sensor control unit and piezoelectric crystal sensor elements that are designed to be rigidly mounted to structure being protected.
b. Detects high-frequency vibrations generated by use of such tools as oxyacetylene torches, oxygen lances, high-speed drills and saws, and explosives that penetrate a structure while not responding to other mechanical vibration.
c. Circular detection pattern, with at least a **72 inch (1830 mm)** radius on protected structure.
d. Hookup Cable: Factory installed, not less than **72 inch (1830 mm)**.
e. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
f. Glass-Break Simulator: A device to induce frequencies to protected glass pane that simulate breaking glass without causing damage to glass.

I. Photoelectric Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**Honeywell International Inc.**]
c. [**Interlogix; Carrier Global Corporation**]
d. [**Optex Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**Honeywell International Inc.**]
c. [**Interlogix; Carrier Global Corporation**]
d. [**Optex Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and

equipment.

4. Standard Features:

   a. Detects interruption of a pulsed, infrared, light beam that links transmitter and receiver.
   b. Sensitivity: Detect standard-intruder movement within sensor's detection patterns at any speed of less than **7.5 ft/s (2.3 m/s)** though the beam.
   c. Allow installation of multiple sensors within same protected zone that will not interfere with each other.
   d. Activation Indicator: LED indicator may not be visible during normal operation. Indicator must light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
   e. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

J. Microwave-PIR Dual-Technology Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Aleph America Corporation**]
   b. [**Honeywell International Inc.**]
   c. [**Interlogix; Carrier Global Corporation**]
   d. [**Visonic Inc**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Aleph America Corporation**]
   b. [**Honeywell International Inc.**]
   c. [**Interlogix; Carrier Global Corporation**]
   d. [**Visonic Inc**]
   e. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. Listed and labeled by a qualified electrical testing agency for compliance with SIA PIR-01.
   d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Single unit combining a sensor that detects changes in microwave signals and a sensor that detects changes in ambient level of passive infrared emissions caused by standard-intruder movement within detection pattern.
   b. Alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
   c. Minimum Detection Pattern: A room **20 by 30 ft (6 by 9 m)**.

d. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of **2 deg F (1 deg C)** or less, and standard-intruder movement within sensor's detection patterns at any speed between **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)** across two adjacent segments of detector's field of view.
e. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at speeds within **0.3 to 7.5 ft/s (0.09 to 2.3 m/s)**.
f. Sensor sensitivity adjustments must be accessible only when sensor housing is removed, and sensors must comply with 47 CFR 15.
g. Activation Indicator: LED indicator may not be visible during normal operation. Indicator must light when sensor detects a standard intruder.
h. Locate test enabling switch under sensor housing cover.
i. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

K. Duress-Alarm Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Honeywell International Inc.**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Visonic Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Honeywell International Inc.**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Visonic Inc**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated.
b. Switch locks in activated position until reset with a key.
c. Minimum Switch Rating: 50,000 operations.
d. Foot Rail: Foot activated, floor mounting.
e. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

L. Video Motion Sensor (Interior) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Aleph America Corporation**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Visonic Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**Interlogix; Carrier Global Corporation**]
c. [**Visonic Inc**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.
b. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
c. Modular design that allows for expansion or modification of number of inputs.
d. Controls:

1) Number of detection zones.
2) Size of detection zones.
3) Sensitivity of detection of each protected zone.

e. Mounting: Standard **19 inch (480 mm)** rack as described in EIA/ECA 310-E.

2.3 CONTROL DEVICES

A. Intrusion Detection Keypad and Display Module :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]

f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

B. Intrusion Detection Key-Operated Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]

g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features: Changes protected zone between secure and access conditions.

C. Intrusion Detection Master Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**DAQ Electronics, Inc**]
c. [**Digital Security Controls Ltd.**]
d. [**Honeywell Commercial Security; Honeywell International, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**DAQ Electronics, Inc**]
c. [**Digital Security Controls Ltd.**]
d. [**Honeywell Commercial Security; Honeywell International, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Visonic Inc**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with [**UL 609**][**UL 1023**][**UL 1076**].
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Supervises sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms

and supervisory and trouble signals, and other indicated functions.

1) System software and programs must be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2) Include real-time clock for time annotation of events on event recorder and printer.
3) Addressable initiation devices that communicate device identity and status.
4) Control circuits for operation of mechanical equipment in response to an alarm.

b. Construction: [**Freestanding equipment rack**][**Desk-mounted console**], modular, with separate and independent alarm and supervisory system modules. [**Alarm-initiating protected zone boards must be plug-in cards.**]Arrangements that require removal of field wiring for module replacement are unacceptable.
c. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
d. Annunciator and Display: LCD, [**one**][**two**][**three**] line(s) of [**40**][**80**] characters, minimum.
e. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
f. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication must return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures must identify the failure and record the failure at the annunciator display and at the system printer.
g. Field Device Network: Communicate between the control unit and field devices of the system. Communications must consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device must be interrogated during each interrogation cycle.
h. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

1) Acknowledge alarm.
2) Silence alarm.
3) System reset.
4) LED test.
5) <**Insert operator functions**>.

i. Timing Unit: Solid state, programmable, 365 days.
j. Confirmation: Relays, contactors, and other control devices must have auxiliary contacts that provide confirmation signals to system for their on or off status. Software must interpret such signals, display equipment status, and initiate failure signals.
k. Alarm Indication:

1) Audible signal sounds and an LED lights at master control unit identifying the [**protected zone**][**addressable detector**] originating the alarm.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
2) Audible signal sounds and a plain-language identification of the [**protected zone**][**addressable detector**] originating the alarm appears on [**LED**][**or**][**LCD**] display at master control unit.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
3) Audible signal sounds and a plain-language identification of the [**protected zone**][**addressable detector**] originating the alarm appears on [**LED**][**LCD**][**or**][**cathode-ray-tube**] display at master control unit.[**Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.**]

4) Alarm activation sounds a [**bell**][**siren**][**strobe**][**bell or siren and strobe**].

l. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of [**25**]<**Insert number**> percent.
m. Power Supply Circuits: Master control units must provide power for remote power-consuming detection devices. Circuit capacity must be adequate for at least a [**25**]<**Insert number**> percent increase in load.
n. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS must be sized to provide a minimum of six hours of master control-unit operation.
o. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate may not be less than **1 inch (25 mm)** high. Identify, with permanent labels, individual components and modules within cabinets.
p. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
q. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.4 NOTIFICATION DEVICES

A. Intrusion Detection Alarm Bell :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
   b. [**Cooper Wheelock; brand of Eaton**]
   c. [**Edwards; Carrier Global Corporation**]
   d. [**Honeywell International Inc.**]
   e. [**Potter Electric Signal Company, LLC**]
   f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
   b. [**Cooper Wheelock; brand of Eaton**]
   c. [**Edwards; Carrier Global Corporation**]
   d. [**Honeywell International Inc.**]
   e. [**Potter Electric Signal Company, LLC**]
   f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. **10 inch (254 mm)** in diameter, rated to produce a minimum sound output of 84 dB at **10 ft (3 m)** from master control unit.
b. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

B. Intrusion Detection Alarm Klaxon :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Weatherproof motor-driven hooter.
b. Rated to produce minimum sound output of 120 dB at **3 ft (1 m)**, plus or minus 3 dB, at frequency of 470 Hz.
c. Rated for intermittent use; two minutes on and five minutes off.
d. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

C. Intrusion Detection Alarm Siren :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. 30 W speaker with siren driver, rated to produce a minimum sound output of 103 dB at **10 ft (3 m)** from master control unit.
b. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

D. Intrusion Detection Alarm Strobe :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]

c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with UL 1638.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Xenon light with clear polycarbonate lens.
b. Light Output: 115 cd, minimum.
c. Flash Rate: 60 per minute.

2.5 SECURITY FASTENERS

A. Socket Flat Countersunk Head Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM F835 (ASTM F835M)**.
d. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

B. Socket Button Head Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM F835 (ASTM F835M)**.
d. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

C. Socket Head Cap Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM A574 (ASTM A574M)**.
d. Stainless steel, **ASTM F837 (ASTM F837M)**, Group 1 CW.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:

1. Electronic door hardware.
2. Elevators.
3. Network lighting controls.
4. Intercommunications and program systems.
5. Public address and mass notification systems.
6. Access control.
7. Fire-alarm system.
8. Perimeter security system.
9. Video surveillance.
10. <**Insert applicable systems and equipment**>.

3.3 INSTALLATION OF INTRUSION DETECTION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than **72 inch (1830 mm)** above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than **72 inch (1830 mm)** above the

finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the Supervising Station.
3. Expand, modify, and supplement existing [**control**][**monitoring**] equipment as necessary to extend existing [**control**][**monitoring**] functions to the new points. New components must be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools must be required to operate security fasteners for Project.[**Provide stainless-steel security fasteners in stainless-steel materials.**]

F. Wiring Method:

1. Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size must be metric designator 13 (trade size 1/2). Control and data transmission wiring may not share conduit with other building wiring systems.
2. Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size must be metric designator 13 (trade size 1/2). Control and data transmission wiring may not share conduit with other building wiring systems.
3. Cable, concealed in accessible ceilings, walls, and floors when possible.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

H. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120 V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
4. Data and Television Signal Transmission Cables: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

I. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

J. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

K. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 260553 "Identification for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

B. Install instructions frame in a location visible from master control unit.

3.5 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide [**5 Ω**]<**Insert resistance**> ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 260526 "Grounding and Bonding for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

3.6 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is

complete and fully operable; include names and titles of witnesses to preliminary tests.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment must be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

E. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

F. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

G. Nonconforming Work:

1. Intrusion detection system will be considered defective if it does not pass tests and inspections.

H. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

I. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**three**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.[**Visits for this purpose must be in addition to any required by warranty.**]

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 28 16 11 00

SECTION 28 16 11 00A - AREA AND PERIMETER INTRUSION DETECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:

1. Sensing devices.
2. Control devices.
3. Notification devices.
4. Security fasteners.

B. Related Sections:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 271313 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.
5. Section 271323 "Communications Optical Fiber Backbone Cabling" for multi- and single-mode backbone (riser-rated) optical fiber.
6. Section 271513 "Communications Copper Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.
7. Section 271523 "Communications Optical Fiber Horizontal Cabling" for multi- and single-mode horizontal (general use, riser-, and plenum-rated) optical fiber.
8. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for cabling between master control units and field-mounted devices and control units.

1.2 DEFINITIONS

A. CCTV: Closed-circuit television.

B. EMI: Electromagnetic interference.

C. PIR: Passive infrared.

D. RFI: Radio-frequency interference.

E. UPS: Uninterruptible power supply.

F. Control Unit: System component that monitors inputs and controls outputs through various circuits.

G. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

H. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

I. Protected Zone: A protected premises or an area within a protected premise that is provided with means to prevent an unwanted event.

J. Standard Intruder: A person who weighs **100 lb (45 kg)** or less and whose height is **60 inch (1525 mm)** or less; dressed in a long-sleeved shirt, slacks, and shoes[**unless environmental conditions at the site require protective clothing**].

K. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

L. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

M. Zone. A defined area within a protected premise. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify [**programmable logic controllers**][**networks**][**and**] control interface devices and media to be used. Describe characteristics of network and other data communication lines.

a. Indicate methods used to achieve systems integration.
b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
c. Describe characteristics of network and other data communication lines.
d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

2. Raceway Riser Diagrams: Detail raceway runs required for perimeter security[**and for systems integration**]. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
3. UPS: Sizing calculations.
4. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.[**Include room layout for master control-unit console, terminal cabinet, racks, and UPS.**]

5. Master Control-Unit Console Layout: Show required artwork and device identification.
6. Device Address List: Coordinate with final system programming.
7. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
8. Details of surge protection.
9. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required.

F. Field quality-control reports.

1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**][**security systems integrator**][**testing agency**].

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field Test Plans: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within [**60 days**]<**Insert number**> of date of Contract award.
3. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For perimeter security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. [**One**]<**Insert number**> spare control-unit board(s) for strain-sensitive cable system and

[**one**]<**Insert number**> cable repair and splice kit(s).

2. [**One**]<**Insert number**> of each type of microwave sensor and one of each type of power supply for microwave perimeter security system.
3. [**One**]<**Insert number**> of each spare sensor and PIR unit and [**one**]<**Insert number**> alignment telescope(s) for long-range PIR system.
4. [**One**]<**Insert number**> spare control-unit board(s) for electrostatic-field system.
5. [**One**]<**Insert number**> spare control-unit board(s) for buried, ported coaxial cable system, **10 ft (3 m)** of cable; and [**one**]<**Insert number**> cable repair and splice kit(s).
6. Fuses: [**Three**]<**Insert number**> of each kind and size.
7. Tool Kit: Provide [**six**]<**Insert number**> sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
8. Security Fasteners: Furnish no fewer than [**1 box for every 50**]<**Insert numbers**> boxes or fraction thereof, of each type and size of security fastener installed.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS International) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

C. Intrusion Detection Systems Installer:

1. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Layout Responsibility: Preparation of Shop Drawings[**and cabling administration Drawings**][**, cabling administration Drawings, and field testing program development**] by [**an RCDD**][**a Technician**].
4. Installation Supervision: Installation must be under the direct supervision of [**Technician**][**Level 2 Commercial Installer**], who must be present at all times when Work of this Section is performed at Project site.

D. Security Systems Integrator: An experienced perimeter security equipment supplier[**and Installer**] who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the requirements specified in Section 018116 "Facility Environmental Requirements" and the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to [**4000 ft (1220 m)**]<**Insert elevation**>.
2. Master Control Unit: Rated for continuous operation in an ambient of **60 to 85 deg F (16 to 29**

deg C) and a relative humidity of 20 to 80 percent, noncondensing.

3. Exterior Environment: System components installed in locations exposed to weather must be rated for continuous operation in ambients of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in UL 50E, winds up to [**85 mph (137 km/h)**][**and snow cover up to 24 inch (610 mm) thick**].
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings must be rated, listed, and installed according to NFPA 70.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of perimeter security devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. System Description: Perimeter protection system with [**fence-mounted systems**][**buried sensors**][**volumetric detectors**] integrated into a single perimeter detection and alarm system.

1. Supervision: System components are to be continuously monitored for normal, alarm, [**supervisory,**]and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

   a. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
   b. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal must indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
   c. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

2. System Control:

   a. Master control unit must directly monitor gate detection devices, perimeter detection units, and connecting wiring.
   b. One or more remote, addressable control units operate under control of a master control-unit microcomputer in a multiplexed distributed control system or as part of a network. Control units must receive programming by multiplexed signal transmission from the associated master control unit and hold data in nonvolatile memory. System must automatically reboot program without error or loss of status or alarm data after any system disturbance.

3. Operator Commands:

   a. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, must produce a short explanation of the purpose, use,

and system reaction to that command.
b. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
c. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
d. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
e. Protected Zone Test: Initiate operational test of a specific protected zone.
f. System Test: Initiate system-wide operational test.
g. Print reports.

4. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
5. Automatic Control of Related Systems: Alarm or supervisory signals from certain perimeter security devices control the following functions in related systems:

a. Switch selected lights.
b. Open a signal path between certain intercommunication stations.
c. Shift sound system to "listening mode" and open a signal path to certain system speakers.
d. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
e. <**Insert description of automatic control required**>.

6. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), control-unit address, protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands must initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
7. Response Time: [**Two**]<**Insert number**> seconds between actuation of any alarm and its indication at master control unit.
8. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, control units, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
9. Programmed Secure-Access Control: System must be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations must override programmed settings.
10. Manual Secure-Access Control: Coded entries at manual stations must change status of associated protected zone between secure and access conditions.

B. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria."

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."

2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

D. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit must be selected and configured with accessories for full compatibility with the following equipment:

1. Door hardware specified in Section 087100 "Door Hardware."
2. Door hardware specified in Section 087111 "Door Hardware (Descriptive Specification)."
3. Lighting controls specified in Section 260923 "Lighting Control Devices."
4. Lighting controls specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."
5. Intercom and program systems specified in Section 275123.20 "Commercial Intercommunications and Program Systems."
6. Intercom and program systems specified in Section 275123.50 "Educational Intercommunications and Program Systems."
7. Access control system specified in Section 281300 "Access Control System Software and Database Management."
8. Intrusion detection system specified in Section 283100 "Intrusion Detection."
9. Video surveillance system specified in Section 282000 "Video Surveillance."
10. <**Insert system or equipment**> specified in Section <**Insert Section number**> "<**Insert Section title**>."

E. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

F. Interference Protection: Components must be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10 000 MHz and conducted interference signals up to 0.25 V(rms) injected into power supply lines at 10 to 10 000 MHz.

G. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components must initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display must identify tamper alarms and indicate locations.

H. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

I. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

J. Addressable Devices: Transmitter and receivers must communicate unique device identification and status reports to master control unit.

K. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually

monitored at master control unit for calibration, sensitivity, and alarm condition.

L. Enclosures:

1. Interior Electronics: UL 50E, Type 12.
2. Exterior Electronics: UL 50E, Type 4X, [**fiberglass**][**stainless steel**].
3. Corrosion Resistant: UL 50E, Type 4X, [**PVC**][**stainless steel**].
4. Terminal cabinets in handholes and manholes must be UL 50E, [**Type 6**][**Type 6P**].
5. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

M. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

2.2 SENSING DEVICES

A. Strain-Sensitive Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BEI Communications, Inc**]
b. [**Integrated Security Corporation**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**BEI Communications, Inc**]
b. [**Integrated Security Corporation**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Fence-mounted strain-sensitive, coaxial transducer cable must monitor chain-link-type and

welded-mesh-type fence and generate an alarm when a standard intruder attempts to climb over, cut through, or lift fence fabric.

b. Environment: Suitable for exterior installation and the following conditions:

1) Ambient Temperatures: Ranging from [**minus 22 to plus 158 deg F (minus 30 to plus 70 deg C)**]<**Insert temperature range**>.
2) <**Insert applicable environmental conditions**>.

c. Transducer Cable:

1) UV-resistant cable furnished by system manufacturer.
2) Suitable for up to **1000 ft (300 m)** of sensor cable per single-zone control unit and up to **2000 ft (600 m)** of sensor cable per dual-zone processor.
3) Sensitivity must be uniform throughout its entire length, requiring only one variable sensitivity adjustment throughout its entire length.

d. Control Unit:

1) Field mounted, with tamper switch at control-unit board.
2) Electronic circuitry must discriminate between acceptable fence movement and intrusion-related disturbances.
3) Sensitivity, count control, and climb-over processors must be adjustable with a minimum of five individual count-control and climb-over adjustments.
4) Control-unit output must have adjustable pulse width to adjust the time the alarm relay will activate per detected intrusion attempt.

e. System Performance:

1) Immune to RFI and EMI environments; interference must have no effect on normal operational characteristics.
2) Trouble and Tamper: Entire sensor system must be fully supervised with individually monitored tamper and supervision alarms. Disconnecting, cutting, or shorting of strain-sensitive cable results in supervisory alarm.
3) Intrusion Simulation: Each zone must have a self-test feature that, when activated by a signal from master control unit will produce an intrusion alarm and verify operation of sensor.

B. Microwave Intrusion Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Crow Electronic Engineering, Inc**]
c. [**Honeywell International Inc.**]
d. [**Integrated Security Corporation**]
e. [**Magal-Senstar, Inc.**]
f. [**Optex Inc.**]
g. [**Southwest Microwave, Inc**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Crow Electronic Engineering, Inc**]
c. [**Honeywell International Inc.**]
d. [**Integrated Security Corporation**]
e. [**Magal-Senstar, Inc.**]
f. [**Optex Inc.**]
g. [**Southwest Microwave, Inc**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Volumetric microwave detection system.
b. Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
c. Movement Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between **0.1 to 50 ft/s (0.03 to 15.2 m/s)**. Sensor sensitivity adjustments are be accessible only when sensor housing is removed, and sensors must comply with 47 CFR 15.
d. Detection Range: **15 to 600 ft (5 to 180 m)**.
e. Range Sensitivity: Adjustable for setting area of protection between **15 to 500 ft (5 to 152 m)** in range and from **2 to 40 ft (0.6 to 12 m)** in beam diameter.
f. Trouble and Tamper: Fully supervised with individually monitored tamper and supervision alarms. System failure must result in tamper alarm. System jamming or wrong modulation must result in supervisory alarm.
g. Activation Indicator: LED indicator is not to be visible during normal operation. Indicator must light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
h. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
i. Environment: Suitable for exterior installation and the following conditions:

1) Ambient Temperatures: Ranging from [**minus 30 to plus 158 deg F (minus 34 to plus 70 deg C)**]<**Insert temperature range**> and in rainfall up to **4 inch (100 mm)**.
2) <**Insert applicable environmental conditions**>.

C. Electrostatic Field :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BEI Communications, Inc**]
b. [**Integrated Security Corporation**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]

f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**BEI Communications, Inc**]
b. [**Integrated Security Corporation**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Fence-mounted[**, independently mounted**], above-ground, electrostatic-field detection system, consisting of electronically balanced phase electrostatic-field detection system with a field generator that generates an electrical field in one or more field wires and that has two or more sensing wires, a sense filter, amplifier, and a control unit.
b. Detection fields must have a minimum of four different frequencies so adjacent zones cannot interfere with each other.
c. Environment: Suitable for exterior installation and the following conditions:

1) Ambient Temperatures: Ranging from [**minus 22 to plus 158 deg F (minus 30 to plus 70 deg C)**]<**Insert temperature range**>.
2) <**Insert applicable environmental conditions**>.

d. System Performance:

1) Detect, via sense wires, a compound signal form consisting of amplitude change, rate of change, and preset time disturbance that forms a "signature" of human movement. Generate an alarm when all exist simultaneously. Provide detection fields of no fewer than four different frequencies so adjacent zones do not interfere with each other.
2) Control Units: Single or multiple zone, with sense filter. Front panel with calibration meter, status of alarm transmitter, sensitivity selector, test point selector, power indicator, and power control. Control unit must reject signals due to wind and small objects striking the wires.
3) Motion Detection: Sense standard-intruder movement at rates from **0.15 to 26 ft/s (0.045 to 8.0 m/s)**.
4) Zone Length: Not to exceed [**500 ft (152 m)**][**325 ft (100 m)**].
5) Supervision: Generate trouble signal if field or sense wires are cut or shorted to ground or to each other. Generate supervisory alarm if received signal is substantially reduced.

e. Insulators, Wire-Tensioning Devices, and Brackets: Manufacturer's standard for mounting and tensioning of wires.
f. Field and Sensing Wires: Stainless steel.

D. Buried, Ported Coaxial Cable :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Magal-Senstar, Inc.**]
   b. [**Safeguards Technology**]
   c. [**Southwest Microwave, Inc**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Magal-Senstar, Inc.**]
   b. [**Safeguards Technology**]
   c. [**Southwest Microwave, Inc**]
   d. <**Insert manufacturer's name**>

3. Listing Criteria:

   a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
   b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
   c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

   a. Buried electrostatic-field detection system consisting of parallel, ported coaxial cables that generate a detection field between cables.
   b. Environment: Suitable for exterior installation and the following conditions:

      1) Ambient Temperatures: Ranging from [**minus 22 to plus 158 deg F (minus 30 to plus 70 deg C)**]<**Insert temperature range**>.
      2) <**Insert applicable environmental conditions**>.

   c. System Performance: One of two parallel cables receives a continuous wave signal from a transmitter module. Second cable, connected to a sensor module, detects, preamplifies, and analyzes variations in signal. When system senses "signature" of a standard intruder in the detection zone, based on mass, motion, and time of day, it generates an alarm.

      1) Transmitter: Locate at one end of zone, with standby battery.
      2) Preamplifier-Sensor: Locate at opposite end from transmitter, with standby battery.
      3) Front panel with sensitivity calibration meter, calibrated self-test potentiometer, power switch, and LED normal and malfunction indicators.
      4) Electromagnetic Radiation: Less than 50 mV per meter at 30 m.
      5) Motion Detection: Sense standard-intruder movement at rates from **0.17 to 26 ft/s (0.05 to 8.0 m/s)**.
      6) Zone Length: Not to exceed [**500 ft (152 m)**][**325 ft (100 m)**].
      7) Zone Width: Not to exceed **15 ft (4.6 m)**, with an average width of **12 ft (3.7 m)**.
      8) Zone Height: Approximately **3.3 ft (1.0 m)**, depending on sensitivity setting.
      9) Supervision: Generate trouble signal if cable is cut or shorted to ground. Generate supervisory alarm if cabinets are tampered with.

d. Enclosures: Hinged cover with tamper switch and security fasteners.
e. Buried, Ported Coaxial Cable: Approximately **1/2 inch (1.3 mm)** diameter, minimum 10 AWG center conductor, foam polyethylene dielectric, braided copper outer conductor, and polyethylene jacket.

E. Long-Range PIR Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**Bosch Security Systems, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**Digital Security Controls Ltd.**]
e. [**Honeywell International Inc.**]
f. [**Integrated Security Corporation**]
g. [**Optex Inc.**]
h. [**Safeguards Technology**]
i. [**Southwest Microwave, Inc**]
j. [**Visonic Inc**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**Bosch Security Systems, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**Digital Security Controls Ltd.**]
e. [**Honeywell International Inc.**]
f. [**Integrated Security Corporation**]
g. [**Optex Inc.**]
h. [**Safeguards Technology**]
i. [**Southwest Microwave, Inc**]
j. [**Visonic Inc**]
k. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA PIR-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Volumetric passive infrared detection system.
b. Environment: Suitable for exterior installation and the following conditions:

1) Ambient Temperatures: Ranging from [**minus 30 to plus 150 deg F (minus 34 to plus 65 deg C)**]<**Insert temperature range**>.
2) <**Insert applicable environmental conditions**>.

c. System Performance: Detect an interruption of dual-infrared light beams that link transmitters and receivers. Generate an alarm when signal is interrupted due to presence of an object that interrupts both beams.

1) Sensitivity: Field adjustable to allow adjustment of range from **25 to 500 ft (7.6 to 152 m)**, generating an alarm within 20 to 50 ms when both beams are interrupted.
2) Detection system must adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
3) Motion Detection: Detect standard-intruder movement at rates from **0.1 to 50 ft/s (0.03 to 15.2 m/s)**.
4) Supervision: Generate supervisory alarm if any portion of system is tampered with.
5) Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

F. Geophone Fence Detection :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**BEI Communications, Inc**]
b. [**Honeywell International Inc.**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**BEI Communications, Inc**]
b. [**Honeywell International Inc.**]
c. [**Magal-Senstar, Inc.**]
d. [**Safeguards Technology**]
e. [**Southwest Microwave, Inc**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Fence-mounted system to detect attempts to cut or climb the protected fence, using geophone sensors that respond to specific shock or vibrations.
b. Environment: Suitable for exterior installation and the following conditions:

1) Ambient Temperatures: Ranging from [**minus 30 to plus 150 deg F (minus 34 to**

plus 65 deg C)]<**Insert temperature range**>.
2) <**Insert applicable environmental conditions**>.

c. System Performance:

1) Control Unit: [**10**]<**Insert number**> zone capacity for processing geophone generated analog signals. Each zone must consist of not more than [**10**]<**Insert number**> sensors.

a) Adjustments: For each zone, provide stepped gain control for sensitivity and switches for geophone signal filters to minimize nuisance alarms. System must adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
b) Trouble Condition Signal: Generate when any zone fails.
c) Supervisory Condition Signal: Generate on interference with control-unit operation or when detecting a break-in into an enclosure housing electronics.

d. Sensors: Fence mounted [20 ft (6 m)]<**Insert dimension**> o.c.
e. Cable for Interconnection of System Components: Shielded, PVC jacketed and armored, as supplied by system manufacturer.
f. Test each zone simulating an alarm condition. Test by [**command from master control**][**test switch at control unit inside the enclosure**].

G. Video Motion Sensor :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Honeywell International Inc.**]
c. [**Magal-Senstar, Inc.**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Honeywell International Inc.**]
c. [**Magal-Senstar, Inc.**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Video-surveillance-based detection system.
b. Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.

1) Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
2) Modular design that allows for expansion or modification of number of inputs.
3) Adjustable Controls:

a) Number of detection zones.
b) Size of detection zones.
c) Sensitivity of detection of each protected zone.

c. Mounting: Standard **19 inch (480 mm)** rack as described in EIA/ECA 310-E.
d. Environment: Suitable for installation in interior air-conditioned spaces. <**Insert applicable environmental conditions**>.

H. Gate Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Aleph America Corporation**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Honeywell International Inc.**]
d. [**Safeguards Technology**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Aleph America Corporation**]
b. [**Honeywell Commercial Security; Honeywell International, Inc.**]
c. [**Honeywell International Inc.**]
d. [**Safeguards Technology**]
e. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Fence-mounted gate-movement detectors, balanced-magnetic type, and UL listed for outdoor locations. Units must be designed for mounting on single- or double-leaf swinging or rolling gates and have armored jumper cables between switch and stationary junction box for wiring to master control unit and tamper switches in junction box.
b. Bias magnet and at least three encapsulated-reed switches that resist compromise from introduction of foreign magnetic fields, with integral overcurrent protective device to limit current to 80 percent of switch capacity.
c. Remote Test: Simulate movement of actuating magnet from master control unit.

2.3 CONTROL DEVICES

A. Intrusion Detection Keypad and Display Module :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

B. Intrusion Detection Key-Operated Switch :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]

g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**Corby Industries, Inc.**]
c. [**Crow Electronic Engineering, Inc**]
d. [**DAQ Electronics, Inc**]
e. [**Digital Security Controls Ltd.**]
f. [**Edwards; Carrier Global Corporation**]
g. [**Honeywell International Inc.**]
h. [**Visonic Inc**]
i. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features: Changes protected zone between secure and access conditions.

C. Field-Mounted Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

3. Standard Features:

a. Field-mounted control units must include the power supply and detector specific functions, and provide for communications with the master control unit. Control unit must include read-only resident software needed for startup, a time clock, and all automatic operations. Software must be downloaded from the master control unit.
b. Battery Backup: UPS, providing [**six**]<**Insert number**> hours of run time during a power outage, with two-rate automatic battery charger to fully recharge batteries within [**12**]<**Insert number**> hours after normal power is restored.

1) Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy.

2) Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger must recharge fully discharged battery within 24 hours.

c. Annunciation: Indicate a change in system condition and switching of system or component to backup power.

D. Master Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**DAQ Electronics, Inc**]
c. [**Digital Security Controls Ltd.**]
d. [**Honeywell Commercial Security; Honeywell International, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Magal-Senstar, Inc.**]
h. [**Safeguards Technology**]
i. [**Southwest Microwave, Inc**]
j. [**Visonic Inc**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Bosch Security Systems, Inc.**]
b. [**DAQ Electronics, Inc**]
c. [**Digital Security Controls Ltd.**]
d. [**Honeywell Commercial Security; Honeywell International, Inc.**]
e. [**Honeywell International Inc.**]
f. [**Interlogix; Carrier Global Corporation**]
g. [**Magal-Senstar, Inc.**]
h. [**Safeguards Technology**]
i. [**Southwest Microwave, Inc**]
j. [**Visonic Inc**]
k. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Comply with [**UL 609**][**UL 681**][**UL 1076**].
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Supervises sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1) System software and programs must be held in flash electrically erasable

programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

2) Include a real-time clock for time annotation of events on the event recorder and printer.
3) Addressable initiation devices that communicate device identity and status.
4) Control circuits for operation of mechanical equipment in response to an alarm.

b. Construction: [**Freestanding equipment rack**][**Desk-mounted console**], modular, with separate and independent alarm and supervisory system modules. [**Alarm-initiating protected zone boards must be plug-in cards.**]Arrangements that require removal of field wiring for module replacement are unacceptable.
c. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
d. Annunciator and Display: LCD type, [**one**][**two**][**three**] line(s) of [**40**][**80**] characters, minimum.
e. Keypad: Arranged to permit entry and execution of programming, display, and control commands
f. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication must return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures must identify the failure and record the failure at the annunciator display and at the system printer.
g. Field Device Network: Communicate between the control unit and field devices of the system. Communications must consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device must be interrogated during each interrogation cycle.
h. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

1) Acknowledge alarm.
2) Silence alarm.
3) System reset.
4) LED test.
5) <**Insert operator functions**>.

i. Timing Unit: Solid state, programmable, 365 days.
j. Confirmation: Relays, contactors, and other control devices must have auxiliary contacts that provide confirmation signals to system for their on or off status. Software must interpret such signals, display equipment status, and initiate failure signals.
k. Alarm Indication:

1) An audible signal sounds and an LED lights at master control unit identifying the [**protected zone**][**addressable detector**] originating the alarm.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
2) An audible signal sounds and a plain-language identification of the [**protected zone**][**addressable detector**] originating the alarm appears on [**LED**][**or**][**LCD**]display at master control unit.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
3) An audible signal sounds and a plain-language identification of the [**protected zone**][**addressable detector**] originating the alarm appears on [**LED**][**LCD**][**or**][**cathode-ray-tube**] display at master control unit.[**Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.**]

4) Alarm activation sounds a [**bell**][**siren**][**strobe**][**bell or siren and strobe**].

l. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of [**25**]<**Insert number**> percent.
m. Power Supply Circuits: Master control units must provide power for remote power-consuming detection devices. Circuit capacity must be adequate for at least a [**25**]<**Insert number**> percent increase in load.
n. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS must be sized to provide a minimum of six hours of master control-unit operation.
o. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate is not to be less than **1 inch (25 mm)** high. Identify, with permanent labels, individual components and modules within cabinets.
p. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
q. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.4 NOTIFICATION DEVICES

A. Intrusion Detection Alarm Bell :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. **10 inch (254 mm)** in diameter, rated to produce a minimum sound output of 84 dB at **10 ft (3 m)** from master control unit.
b. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

B. Intrusion Detection Alarm Klaxon :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Weatherproof motor-driven hooter.
b. Rated to produce minimum sound output of 120 dB at **3 ft (1 m)**, plus or minus 3 dB, at frequency of 470 Hz.
c. Rated for intermittent use; two minutes on and five minutes off.
d. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

C. Intrusion Detection Alarm Siren :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**Cooper Wheelock; brand of Eaton**]
    c. [**Edwards; Carrier Global Corporation**]
    d. [**Honeywell International Inc.**]
    e. [**Potter Electric Signal Company, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**Cooper Wheelock; brand of Eaton**]
    c. [**Edwards; Carrier Global Corporation**]
    d. [**Honeywell International Inc.**]
    e. [**Potter Electric Signal Company, LLC**]
    f. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
    b. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
    c. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

    a. 30 W speaker with siren driver, rated to produce a minimum sound output of 103 dB at **10 ft (3 m)** from master control unit.
    b. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

D. Intrusion Detection Alarm Strobe :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**Cooper Wheelock; brand of Eaton**]
    c. [**Edwards; Carrier Global Corporation**]
    d. [**Honeywell International Inc.**]
    e. [**Potter Electric Signal Company, LLC**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Alarm Controls; Hanchett Entry Systems, Inc.; ASSA ABLOY Group**]
    b. [**Cooper Wheelock; brand of Eaton**]

c. [**Edwards; Carrier Global Corporation**]
d. [**Honeywell International Inc.**]
e. [**Potter Electric Signal Company, LLC**]
f. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Listed and labeled by a qualified electrical testing agency for compliance with UL 639.
b. UL 1638.
c. Listed and labeled by a qualified electrical testing agency for compliance with SIA CP-01.
d. FM Global Compliance: FM Approved and labeled perimeter security devices and equipment.

4. Standard Features:

a. Xenon light with clear polycarbonate lens.
b. Light Output: 115 cd, minimum.
c. Flash Rate: 60 per minute.

2.5 SECURITY FASTENERS

A. Socket Flat Countersunk Head Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM F835 (ASTM F835M)**.
d. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

B. Socket Button Head Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the**

following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM F835 (ASTM F835M)**.
d. Stainless steel, **ASTM F879 (ASTM F879M)**, Group 1 CW.

C. Socket Head Cap Fastener :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Acument Global Technologies, Inc.; Acument Intellectual Properties, LLC**]
b. [**Safety Socket LLC**]
c. [**Tamper-Pruf Screws**]
d. <**Insert manufacturer's name**>

3. Standard Features:

a. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
b. Drive System Types: [**Pinned Torx-Plus**][**pinned Torx**][**or**][**pinned hex (Allen)**].
c. Heat-treated alloy steel, **ASTM A574 (ASTM A574M)**.
d. Stainless steel, **ASTM F837 (ASTM F837M)**, Group 1 CW.

2.6 SOURCE QUALITY CONTROL

A. Electrostatic-Field and Buried, Ported Coaxial Cable Systems Electronics: Precondition at factory by subjecting modules to at least four days' operational burn-in at temperatures not less than **140 deg F (60 deg C)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of perimeter security.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of perimeter security connections before perimeter security installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of perimeter security.

D. Inspect built-in and cast-in anchor installations, before installing perimeter security, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEMS INTEGRATION

A. Integrate perimeter security system with the following systems and equipment:

1. Electronic door hardware.
2. Elevators.
3. Network lighting controls.
4. Intercommunications and program systems.
5. Public address and mass notification systems.
6. Access control.
7. Fire-alarm system.
8. Intrusion detection system.
9. Video surveillance.
10. <**Insert applicable systems and equipment**>.

3.3 INSTALLATION OF AREA AND PERIMETER INTRUSION DETECTION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than **72 inch (1830 mm)** above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than **72 inch (1830 mm)** above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the Supervising Station.
3. Expand, modify, and supplement existing [**control**][**monitoring**] equipment as necessary to extend existing [**control**][**monitoring**] functions to the new points. New components must be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to public, install perimeter security components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools must be required to operate security fasteners for Project.[**Provide stainless steel security fasteners in stainless steel materials.**]

F. Wiring Method: Install power, signal, and data transmission wire and cable in metal raceways according to Section 260543 "Underground Ducts and Raceways for Electrical Systems" and Section 270528 "Pathways for Communications Systems." Minimum conduit size must be metric designator 13 (trade size 1/2). Control and data transmission wiring are not to share conduit with other building wiring systems.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with perimeter security system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

H. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120 V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Cable for Low-Voltage Control and Signal Circuits: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
4. Data and Television Signal Transmission Cables: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

I. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

J. Install power supplies and other auxiliary components for detection devices at control units unless

otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

K. Stain-Sensitive Transducer Cable: Attached to fence at **12 inch (300 mm)** intervals with tie wraps.

L. Electrostatic-Field System: Install field and sense wires on insulators and standoffs on a fence, wall, or roof. Provide intermediate supports recommended in writing by manufacturer as needed for specified performance.

M. Buried, Ported Coaxial Cable: Transmitters may be located at one end of parallel coaxial cables, and preamplifier-sensor module may be located at opposite end. Install cable so shield is uniform throughout the length, without twisting or distorting cable during installation. Field-cut cables to exact zone length at the site. To attach data transmission cable to sensing cable, use heat-shrink splice kits approved by manufacturer. Provide sufficient overlap of detector cables to eliminate the possibility of entry between zones.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 260553 "Identification for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

B. Install instructions frame in a location visible from master control unit.

3.5 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide [**5 Ω**]<**Insert resistance**> ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 260526 "Grounding and Bonding for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

3.6 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Perimeter security systems and other systems and equipment that are associated with detection and accessory equipment must be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
3. Geophone System Tests: Test each zone at a minimum of two different locations. Test each zone as follows:

    a. Horizontal Movement: Adjust sensitivity to screen out alarms from wind.
    b. Vertical Climb: 100 percent detection required. Set count at three occurrences within 90-second window.
    c. Cut Test: 100 percent detection required. Set count at two occurrences within 120-second window.
    d. Set sensitivity to value as low as possible, consistent with reliable detection.
    e. If performance tests fail, make adjustments to sensors to comply with requirements. Retest failing and adjacent zones to comply with test.

4. Strain-Sensitive Cable System Tests: Adjust sensitivity and count control to value as low as possible, consistent with reliable detection.
5. Microwave Perimeter Security System Tests: Adjust sensitivity to value as low as possible, consistent with reliable detection.
6. Long-Range PIR System Tests: Adjust sensitivity and hold time between activity duration to value as low as possible, consistent with reliable detection.

E. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

F. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

G. Nonconforming Work:

1. Intrusion detection system will be considered defective if it does not pass tests and inspections.

H. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

I. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other than normal occupancy hours for this purpose.[**Visits for this purpose must be in addition to any required by warranty.**]

3.8 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain the perimeter security system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 28 16 11 00A

Task	Specification	Specification Description
28 16 11 00	26 33 43 00a	Public Address Systems
28 16 11 00	27 41 23 00	Educational Intercommunications and Program Systems
28 16 11 00	28 10 00 00	Access Control
28 16 11 00	28 10 00 00a	Access Control Software and Database Management
28 16 11 00	28 10 00 00b	Access Control System Hardware
28 18 00 00	28 10 00 00	Access Control
28 18 00 00	28 10 00 00a	Access Control Software and Database Management
28 18 00 00	28 10 00 00b	Access Control System Hardware
28 18 11 00	28 10 00 00	Access Control
28 18 11 00	28 10 00 00a	Access Control Software and Database Management
28 18 11 00	28 10 00 00b	Access Control System Hardware

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SECTION 28 20 00 00 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard cameras.
2. Submersible cameras.
3. Reinforced dome cameras.
4. Lenses.
5. Infrared illuminators.
6. Camera-supporting equipment.
7. Monitors.
8. Videotape recorders.
9. Digital video recorders.
10. Network video recorders.
11. Digital switchers.
12. IP video systems.
13. Video motion sensors (interior).
14. Control stations.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 281300 "Access Control System Software and Database Management" to integrate access control system interface and control.
5. Section 283100 "Intrusion Detection" to integrate video surveillance used for intrusion detection.
6. Section 283121 "Area and Perimeter Intrusion Detection" to integrate video surveillance used for intrusion detection.
7. Section 285213 "Detention Monitoring and Control System and Interfaces" to integrate video surveillance with detention monitoring interface and control.

1.2 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. WAN: Wide area network.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
4. UPS: Sizing calculations.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: In addition to seismic qualification data specified in Section 260010 "Supplemental Requirements for Electrical," submit certificates for cameras, camera-supporting

equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.6 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site security testing supervisor must have [**ASIS**][**PSP**]<**Insert organization**> certification and documented training and experience with testing security equipment in accordance with [**ASIS**]<**Insert organization**> testing standards.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the requirements specified in Section 018116 "Facility Environmental Requirements" and the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of **60 to 85 deg F (16 to 29 deg C)** and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in [**air-conditioned**][**temperature-controlled**] interior environments are to be rated for continuous operation in ambient temperatures of [**36 to 122 deg F (2 to 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing. Use UL 50E, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non-[**air-**

conditioned][**temperature-controlled**] interior environments are to be rated for continuous operation in ambient temperatures of [**0 to 122 deg F (minus 18 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing. Use UL 50E, [**Type 3R**][**Type 4**][**Type 12**][**Type 12K**] enclosures.

4. Exterior Environment: System components installed in locations exposed to weather are to be rated for continuous operation in ambient temperatures of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**]<**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in UL 50E, winds up to **85 mph (137 km/h)**[**and snow cover up to 24 inches (610 mm) thick**]. Use UL 50E, [**Type 3**][**Type 3R**][**Type 3S**][**Type 4**][**Type 4X**] enclosures.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers are to be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use UL 50E, [**Type 4X**][**Type 6P**] enclosures.
7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Three**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Video-signal format must comply with NTSC standard, composite interlaced video. Composite video-signal termination must be 75 Ω.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components are to initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display is to identify tamper alarms and indicate locations.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria."

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."
2. Component Importance Factor (Ip): [**1.0**][**1.5**].
3. Component Amplification Factor (ap): [**1.0**][**2.5**]<**Insert value**>.
4. Component Response Modification Factor (Rp): [**1.5**][**2.0**][**2.5**][**6.0**]<**Insert value**>.
5. Component Overstrength Factor (Ωo): [**1.5**][**2.5**]<**Insert value**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NECA 1.

D. Comply with NFPA 70.

E. Electronic data exchange between video surveillance system with an access-control system is to comply with SIA TVAC.

2.3 STANDARD CAMERAS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Axis Communications**]
3. [**Bosch Security Systems, Inc.**]
4. [**CBC (AMERICA) Corp**]
5. [**COP-USA**]
6. [**Crest Electronics, Inc**]
7. [**Elbex Ltd.**]
8. [**ELMO**]
9. [**EverFocus Electronics Corporation**]
10. [**Hitachi Cable America Inc.**]
11. [**Honeywell Commercial Security; Honeywell International, Inc.**]
12. [**Hunt Electronics USA, Inc**]
13. [**Ikegami Electronics (USA) Inc**]
14. [**Interlogix; Carrier Global Corporation**]
15. [**JVC Americas Corp.**]
16. [**Merit Li-Lin (USA) Corp.**]
17. [**Panasonic Corporation of North America**]
18. [**Pelco**]
19. [**Pixera Corporation**]
20. [**Safety Vision**]
21. [**Samsung Opto-Electronics**]
22. [**SANYO North America Corporation**]
23. [**Telpix Electronics, Inc.**]
24. [**Toshiba International Corporation**]
25. [**Trinus Systems Inc.**]
26. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions**

North America]
27. [**Vicon Industries, Inc**]
28. [**Videology Imaging Solutions, Inc.**]
29. [**Visiontech**]
30. [**VIVOTEK Inc.**]
31. [**Watec America Corporation**]
32. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Axis Communications**]
3. [**Bosch Security Systems, Inc.**]
4. [**CBC (AMERICA) Corp**]
5. [**COP-USA**]
6. [**Crest Electronics, Inc**]
7. [**Elbex Ltd.**]
8. [**ELMO**]
9. [**EverFocus Electronics Corporation**]
10. [**Hitachi Cable America Inc.**]
11. [**Honeywell Commercial Security; Honeywell International, Inc.**]
12. [**Hunt Electronics USA, Inc**]
13. [**Ikegami Electronics (USA) Inc**]
14. [**Interlogix; Carrier Global Corporation**]
15. [**JVC Americas Corp.**]
16. [**Merit Li-Lin (USA) Corp.**]
17. [**Panasonic Corporation of North America**]
18. [**Pelco**]
19. [**Pixera Corporation**]
20. [**Safety Vision**]
21. [**Samsung Opto-Electronics**]
22. [**SANYO North America Corporation**]
23. [**Telpix Electronics, Inc.**]
24. [**Toshiba International Corporation**]
25. [**Trinus Systems Inc.**]
26. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
27. [**Vicon Industries, Inc**]
28. [**Videology Imaging Solutions, Inc.**]
29. [**Visiontech**]
30. [**VIVOTEK Inc.**]
31. [**Watec America Corporation**]
32. <**Insert manufacturer's name**>

C. B/W Camera:

1. Comply with UL 639.
2. Pickup Device: CCD interline transfer, 252,000 [**512(H) by 492(V)**]<**Insert other**> pixels.
3. Horizontal Resolution: 380 lines.
4. Signal-to-Noise Ratio: Not less than 46 dB.
5. With AGC, manually selectable on or off.
6. Sensitivity:

    a. Usable images in low-light conditions: Able to deliver an image at a scene illumination of

<**Insert light level**> lux at f/1.4[**, with camera AGC off**].

b. Peak-to-peak signal strength: Deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test is to be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.

7. Manually selectable modes for backlight compensation or normal lighting.
8. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera is to revert to internally generated synchronization on loss of external synch signal.
9. Motion Detector: Built-in digital.

D. Color Camera:

1. Comply with UL 639.
2. Pickup Device: CCD interline transfer, 380,000 [**771(H) by 492(V)**]<**Insert other**> pixels.
3. Horizontal Resolution: 480 lines.
4. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
5. With AGC, manually selectable on or off.
6. Sensitivity:

a. Usable images in low-light conditions: Able to deliver an image at a scene illumination of <**Insert light level**> lux at f/1.4[**, with camera AGC off**].

b. Peak-to-peak signal strength: Deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test is to be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.

7. Manually selectable modes for backlight compensation or normal lighting.
8. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera is to revert to internally generated synchronization on loss of external synch signal.
9. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
10. Motion Detector: Built-in digital.

E. Automatic Color Dome Camera: Assembled and tested as a manufactured unit, containing dome assembly, color camera, motorized pan and tilt, zoom lens, and receiver/driver.

1. Comply with UL 639.
2. Pickup Device: CCD interline transfer, 380,000 [**768(H) by 494(V)**]<**Insert other**> pixels.
3. Horizontal Resolution: 480 lines.
4. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
5. With AGC, manually selectable on or off.
6. Sensitivity:

a. Usable images in low-light conditions: Able to deliver an image at a scene illumination of <**Insert light level**> lux at f/1.4[**, with camera AGC off**].

b. Peak-to-peak signal strength: Deliver 1 V peak-to-peak video signal at the minimum specified light level. Illumination for the test is to be with lamps rated at approximately 2200 K color temperature, and with camera AGC off.

7. Manually selectable modes for backlight compensation or normal lighting.
8. Pan and Tilt: Direct-drive motor, 360-degree rotation angle, and 180-degree tilt angle. Pan-and-tilt speed is to be controlled by operator. Movement from preset positions is not to be less than 300 degrees per second.
9. Preset Positioning: Eight user-definable scenes, each allowing 16-character titles. Controls are to include the following:

a. In "sequence mode," camera is to continuously sequence through preset positions, with dwell time and sequencing under operator control.

b. Motion detection is to be available at each camera position.
c. Up to four preset positions may be selected to be activated by an alarm. Each of the alarm positions may be programmed to output a response signal.

10. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera is to revert to internally generated synchronization on loss of external synch signal.
11. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
12. Motion Detector: Built-in digital.
13. Dome is to support multiplexed control communications using coaxial cable recommended by manufacturer.

2.4 SUBMERSIBLE CAMERAS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**International Space Optics**]
2. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**International Space Optics**]
2. <**Insert manufacturer's name**>

C. Camera: Color, designed for underwater monitoring and for inspecting pipes and storm drains. Attributes as follows:

1. Infrared LEDs to provide illumination in zero-light conditions.
2. **60 ft (18.3 m)** factory-installed cable with BNC connector for video and a 2.1 mm jack for 12 V(dc) power supply.
3. An adjustable swivel mount and attachment base.
4. Pickup Device: CCD interline transfer, 290,000 [**500(H) by 580(V)**]<**Insert other**> pixels.
5. Horizontal Resolution: 380 lines.
6. Signal-to-Noise Ratio: Not less than 50 dB.
7. With AGC, from 4 to 39 dB.
8. Sensitivity: Camera is to provide usable images in low-light conditions, delivering an image at a scene illumination of 0.1 lux at f/2.0.
9. Scanning Synchronization: Internal.
10. White Balance: Auto-tracing white balance, for colors ranging from 2800 to 8200 K.

2.5 REINFORCED DOME CAMERAS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Axis Communications**]
2. [**Bosch Security Systems, Inc.**]
3. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Axis Communications**]
2. [**Bosch Security Systems, Inc.**]
3. <**Insert manufacturer's name**>

C. Camera: Designed for high-abuse locations, with a weathertight [**semirecessed**][**surface**] mounting, impact-resistance polycarbonate dome, and heavy-gage, 6061 T6 aluminum body.

1. Suitable for exterior environment, rated for continuous operation in ambient temperatures of **minus 40 to plus 122 deg F (minus 40 to plus 50 deg C)** dry bulb and up to 85 percent relative humidity.
2. Pickup Device: CCD interline transfer, 290,000 [**510(H) by 492(V)**]<**Insert other**> pixels.
3. Horizontal Resolution: 350 lines.
4. Signal-to-Noise Ratio: Not less than 46 dB.
5. With AGC and automatic backlight compensation.
6. Sensitivity: Camera is to provide usable images in low-light conditions, delivering an image at a scene illumination of 6 lux at f/2.0.
7. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera is to revert to internally generated synchronization on loss of external synch signal.
8. White Balance: Auto-tracing white balance.

2.6 LENSES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**Hitachi Cable America Inc.**]
7. [**Honeywell Commercial Security; Honeywell International, Inc.**]
8. [**Hunt Electronics USA, Inc**]
9. [**Interlogix; Carrier Global Corporation**]
10. [**International Space Optics**]
11. [**Panasonic Corporation of North America**]
12. [**Pelco**]
13. [**Samsung Opto-Electronics**]
14. [**SANYO North America Corporation**]
15. [**Tamron USA, Inc.**]
16. [**Telpix Electronics, Inc.**]
17. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
18. [**Vicon Industries, Inc**]
19. [**Videology Imaging Solutions, Inc.**]
20. [**Watec America Corporation**]
21. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bosch Security Systems, Inc.**]

2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**Hitachi Cable America Inc.**]
7. [**Honeywell Commercial Security; Honeywell International, Inc.**]
8. [**Hunt Electronics USA, Inc**]
9. [**Interlogix; Carrier Global Corporation**]
10. [**International Space Optics**]
11. [**Panasonic Corporation of North America**]
12. [**Pelco**]
13. [**Samsung Opto-Electronics**]
14. [**SANYO North America Corporation**]
15. [**Tamron USA, Inc.**]
16. [**Telpix Electronics, Inc.**]
17. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
18. [**Vicon Industries, Inc**]
19. [**Videology Imaging Solutions, Inc.**]
20. [**Watec America Corporation**]
21. <**Insert manufacturer's name**>

C. Description: Optical-quality coated lens, designed specifically for video-surveillance applications and matched to specified camera. Provide color-corrected lenses with color cameras.

1. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
2. Fixed Lens: With calibrated focus ring.
3. Zoom Lens: Motorized, remote-controlled unit, rated as "quiet operating." Features include the following:

    a. Electrical Leads: Filtered to minimize video signal interference.
    b. Motor Speed: Variable.
    c. Lens is to be available with preset positioning capability to recall the position of specific scenes.

2.7 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera[**, infrared illuminator,**] and lens.

1. Enclosure: UL 50E, [**Type 1**][**Type 3**][**Type 4X**]<**Insert type**>.

2.8 INFRARED ILLUMINATORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Honeywell Commercial Security; Honeywell International, Inc.**]
2. [**International Space Optics**]
3. [**Merit Li-Lin (USA) Corp.**]
4. [**Visiontech**]

5. [**VIVOTEK Inc.**]
6. [**Watec America Corporation**]
7. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Honeywell Commercial Security; Honeywell International, Inc.**]
2. [**International Space Optics**]
3. [**Merit Li-Lin (USA) Corp.**]
4. [**Visiontech**]
5. [**VIVOTEK Inc.**]
6. [**Watec America Corporation**]
7. <**Insert manufacturer's name**>

C. Description: Lighting fixtures that emit light only in the infrared spectrum, suitable for use with cameras indicated, for nighttime surveillance, without emitting visible light.

1. Field-Selectable Beam Patterns: Narrow, medium, and wide.
2. Rated Lamp Life: More than 8000 hours.
3. Power Supply: [**12 V(ac/dc)**][**120 V(ac)**].

D. Area Coverage: Illumination to **150 ft (50 m)** in a narrow beam pattern.

E. Exterior housings are to be suitable for same environmental conditions as the associated camera.

2.9 CAMERA-SUPPORTING EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**ELMO**]
7. [**EverFocus Electronics Corporation**]
8. [**Honeywell Commercial Security; Honeywell International, Inc.**]
9. [**Ikegami Electronics (USA) Inc**]
10. [**Interlogix; Carrier Global Corporation**]
11. [**Merit Li-Lin (USA) Corp.**]
12. [**Moog, Inc.**]
13. [**Panasonic Corporation of North America**]
14. [**Pelco**]
15. [**Samsung Opto-Electronics**]
16. [**SANYO North America Corporation**]
17. [**Telpix Electronics, Inc.**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. [**Video Mount Products**]
21. [**Visiontech**]
22. [**Wren Associates Limited**]

23. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**ELMO**]
7. [**EverFocus Electronics Corporation**]
8. [**Honeywell Commercial Security; Honeywell International, Inc.**]
9. [**Ikegami Electronics (USA) Inc**]
10. [**Interlogix; Carrier Global Corporation**]
11. [**Merit Li-Lin (USA) Corp.**]
12. [**Moog, Inc.**]
13. [**Panasonic Corporation of North America**]
14. [**Pelco**]
15. [**Samsung Opto-Electronics**]
16. [**SANYO North America Corporation**]
17. [**Telpix Electronics, Inc.**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. [**Video Mount Products**]
21. [**Visiontech**]
22. [**Wren Associates Limited**]
23. <**Insert manufacturer's name**>

C. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

D. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action, and equipped with matching mounting brackets.

1. Scanning Operation: Silent, smooth, and positive.
2. Stops: Adjustable without disassembly, to limit the scanning arc.

E. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.

1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
3. Speed: 12 degrees per second in both horizontal and vertical planes.
4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
5. Built-in encoders or potentiometers for position feedback[**, and thermostat-controlled heater**].
6. Pan-and-tilt unit is to be available with preset positioning capability to recall the position of a specific scene.

F. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

G. Protective Housings for Fixed and Movable Cameras: Steel[**or 6061 T6 aluminum**] enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and

mounting and installing arrangement of camera to be housed.

1. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit is to identify tamper alarms and indicate location in alarm display. Tamper switches and central-control unit are specified in Section 283100 "Intrusion Detection."
2. Camera Viewing Window: [**Polycarbonate**][**Lexan**] window, aligned with camera lens.
3. Duplex Receptacle: Internally mounted.
4. Alignment Provisions: Camera mounting is to provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
5. Built-in, thermostat-activated [**heater**][**and**][**blower**] units. Units are to be automatically controlled so the environmental limits of the camera equipment are not exceeded.
6. Sun shield is not to interfere with normal airflow around the housing.
7. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket is to be of same material as the housing; mounting hardware is to be stainless steel.
8. Finish: Housing and mounting bracket are to be factory finished using manufacturer's standard finishing process suitable for the environment.
9. Enclosure Rating: <**Insert UL 50E Type designation**><**Insert Ingress Protection code designation**>.

2.10 MONITORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**ELMO**]
7. [**EverFocus Electronics Corporation**]
8. [**Hitachi Cable America Inc.**]
9. [**Honeywell Commercial Security; Honeywell International, Inc.**]
10. [**Hunt Electronics USA, Inc**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**International Space Optics**]
14. [**JVC Americas Corp.**]
15. [**Merit Li-Lin (USA) Corp.**]
16. [**Panasonic Corporation of North America**]
17. [**Pelco**]
18. [**Samsung Opto-Electronics**]
19. [**SANYO North America Corporation**]
20. [**Tatung Company of America, Inc**]
21. [**Telpix Electronics, Inc.**]
22. [**Toshiba International Corporation**]
23. [**Trinus Systems Inc.**]
24. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
25. [**Vicon Industries, Inc**]
26. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's**

name; product name or designation> or comparable product by one of the following:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**ELMO**]
7. [**EverFocus Electronics Corporation**]
8. [**Hitachi Cable America Inc.**]
9. [**Honeywell Commercial Security; Honeywell International, Inc.**]
10. [**Hunt Electronics USA, Inc**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**International Space Optics**]
14. [**JVC Americas Corp.**]
15. [**Merit Li-Lin (USA) Corp.**]
16. [**Panasonic Corporation of North America**]
17. [**Pelco**]
18. [**Samsung Opto-Electronics**]
19. [**SANYO North America Corporation**]
20. [**Tatung Company of America, Inc**]
21. [**Telpix Electronics, Inc.**]
22. [**Toshiba International Corporation**]
23. [**Trinus Systems Inc.**]
24. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
25. [**Vicon Industries, Inc**]
26. <**Insert manufacturer's name**>

C. Monochrome:

1. Metal cabinet units designed for continuous operation.
2. Screen Size (Diagonal Dimension): <**Insert dimension**>.
3. Horizontal Resolution: [**600**]<**Insert resolution**> lines, minimum, at center.
4. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, horizontal-hold, vertical-hold, and contrast controls.
5. Mounting:
    a. Adjustable tilting and training.
    b. [**Single, 14 inch (356 mm)**][**Dual, 9 inch (229 mm)**], vertical, EIA **19 inch (483 mm)** electronic equipment rack or cabinet complying with CEA 310-E.
6. Electrical: 120 V(ac), 60 Hz.

D. Color:

1. Metal cabinet units designed for continuous operation.
2. Screen Size (Diagonal Dimension): <**Insert dimension**>.
3. Horizontal Resolution: [**300**]<**Insert resolution**> lines.
4. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, contrast, color, and tint controls.
5. Degaussing: Automatic.
6. Mounting: [**Single, 14 inch (356 mm)**][**Dual, 9 inch (229 mm)**], vertical, EIA **19 inch (483 mm)** electronic equipment rack or cabinet complying with CEA 310-E.

7. Electrical: 120 V(ac), 60 Hz.

2.11 VIDEOTAPE RECORDERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**Honeywell Commercial Security; Honeywell International, Inc.**]
7. [**Ikegami Electronics (USA) Inc**]
8. [**Interlogix; Carrier Global Corporation**]
9. [**JVC Americas Corp.**]
10. [**Panasonic Corporation of North America**]
11. [**Pelco**]
12. [**Samsung Opto-Electronics**]
13. [**SANYO North America Corporation**]
14. [**Toshiba International Corporation**]
15. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
16. [**Vicon Industries, Inc**]
17. [**Videology Imaging Solutions, Inc.**]
18. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**Bosch Security Systems, Inc.**]
2. [**CBC (AMERICA) Corp**]
3. [**COP-USA**]
4. [**Crest Electronics, Inc**]
5. [**Elbex Ltd.**]
6. [**Honeywell Commercial Security; Honeywell International, Inc.**]
7. [**Ikegami Electronics (USA) Inc**]
8. [**Interlogix; Carrier Global Corporation**]
9. [**JVC Americas Corp.**]
10. [**Panasonic Corporation of North America**]
11. [**Pelco**]
12. [**Samsung Opto-Electronics**]
13. [**SANYO North America Corporation**]
14. [**Toshiba International Corporation**]
15. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
16. [**Vicon Industries, Inc**]
17. [**Videology Imaging Solutions, Inc.**]
18. <**Insert manufacturer's name**>

C. Description: Industrial, time-lapse type recorder, designed for continuous operation. Tape format is **1/2 inch (13 mm)** using industrial-grade, T-120 cassettes.

1. Horizontal Resolution: 400 lines, minimum.

2. Recording Heads: Rotary-scan type.
3. Integral Timer: Permits programming of recording operation for adjustable daily and weekly periods.
4. Time-Lapse Operating Modes: Multiple, covering 24 to 240 hours, minimum.
5. Other Operating Modes:

    a. Manual play and recording at two- and six-hour speeds.
    b. Forward and reverse high-speed search.
    c. Reverse, slow, and single-frame play.

6. Alarm Recording: Operating mode is automatically switched from time-lapse to two- or six-hour recording mode when an externally generated alarm signal is received.
7. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
8. Time and Date Generator: Records time and date legend in corner of recorded scenes.
9. Tape Counter: Displays tape position.
10. Manual Recording Lock: Key or keypad operated. Prevents unauthorized tampering or control changes during preset operation.
11. Signal-to-Noise Ratio: 45 dB for video output in standard play mode.
12. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E, or freestanding desktop.

2.12 DIGITAL VIDEO RECORDERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Samsung Opto-Electronics**]
17. [**SANYO North America Corporation**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]

4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Samsung Opto-Electronics**]
17. [**SANYO North America Corporation**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. <**Insert manufacturer's name**>

C. Description: Digital, time-lapse type, full-frame and motion recorder, with removable hard drive.

1. Recording Time: 400 hours minimum.
2. Resolution: 720 by 480 lines, minimum.
3. Programming is to be from trackball and push buttons on face of the recorder, settings are to be displayed on any video monitor connected to the recorder. Programming is to include the following:

    a. Motion analysis graph.
    b. Password protection.
    c. Alarm and timer controls.
    d. Continuous recording option.
    e. Time-lapse operating modes.
    f. Search video by time, event, or motion.

4. Programming: SmartMedia card for software updating, image archiving, and image transfer to a PC.
5. Storage: [**80 GB**]<**Insert size**>, removable hard drive. Software is to permit hot-swapping drives.
6. Compression: [**MPEG-2**]<**Insert type**>.
7. Time and Date Generator: Records time (hr:min:sec) and date legend of each frame.
8. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
9. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E, or freestanding desktop.

2.13 NETWORK VIDEO RECORDERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]

8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Samsung Opto-Electronics**]
17. [**SANYO North America Corporation**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. [**VIVOTEK Inc.**]
21. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Samsung Opto-Electronics**]
17. [**SANYO North America Corporation**]
18. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
19. [**Vicon Industries, Inc**]
20. [**VIVOTEK Inc.**]
21. <**Insert manufacturer's name**>

C. External storage or internal 250 to 1500 GB hard disk drive.

1. Video and audio recording over TCP/IP network.
2. Video recording of MPEG-2 and MPEG-4 streams.
3. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
4. Duplex Operation: Simultaneous recording and playback.
5. Continuous and alarm-based recording.
6. Full-Featured Search Capabilities: Search based on camera, time, or date.
7. Automatic data replenishment to ensure recording even if network is down.
8. Digital certification by watermarking.
9. Internal RAID storage or non-RAID storage of up to 1500 GB.
10. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
11. Full integration with LAN, Intranet, or Internet through standard Web browser or video

management software.
12. Integrated Web server FTP server functionality.
13. Supports up to 16[**, 32,**] or [**64**]<**Insert number**> devices.

2.14 DIGITAL SWITCHERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**Communications Specialties, Inc.**]
5. [**Convision Systems GmbH**]
6. [**COP-USA**]
7. [**Crest Electronics, Inc**]
8. [**Dedicated Microcomputers Limited**]
9. [**Elbex Ltd.**]
10. [**EverFocus Electronics Corporation**]
11. [**Honeywell Commercial Security; Honeywell International, Inc.**]
12. [**Hunt Electronics USA, Inc**]
13. [**Ikegami Electronics (USA) Inc**]
14. [**Interlogix; Carrier Global Corporation**]
15. [**JVC Americas Corp.**]
16. [**Merit Li-Lin (USA) Corp.**]
17. [**Panasonic Corporation of North America**]
18. [**Pelco**]
19. [**Samsung Opto-Electronics**]
20. [**SANYO North America Corporation**]
21. [**Telpix Electronics, Inc.**]
22. [**Toshiba International Corporation**]
23. [**Trinus Systems Inc.**]
24. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
25. [**Vicon Industries, Inc**]
26. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**Communications Specialties, Inc.**]
5. [**Convision Systems GmbH**]
6. [**COP-USA**]
7. [**Crest Electronics, Inc**]
8. [**Dedicated Microcomputers Limited**]
9. [**Elbex Ltd.**]
10. [**EverFocus Electronics Corporation**]
11. [**Honeywell Commercial Security; Honeywell International, Inc.**]
12. [**Hunt Electronics USA, Inc**]
13. [**Ikegami Electronics (USA) Inc**]
14. [**Interlogix; Carrier Global Corporation**]

15. [**JVC Americas Corp.**]
16. [**Merit Li-Lin (USA) Corp.**]
17. [**Panasonic Corporation of North America**]
18. [**Pelco**]
19. [**Samsung Opto-Electronics**]
20. [**SANYO North America Corporation**]
21. [**Telpix Electronics, Inc.**]
22. [**Toshiba International Corporation**]
23. [**Trinus Systems Inc.**]
24. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
25. [**Vicon Industries, Inc**]
26. <**Insert manufacturer's name**>

C. Quad Switch: For displaying images from four cameras on a single monitor. Provide color switcher if one or more cameras or monitors are in color.

1. Controls: Unit-mounted front panel.
2. Resolution: [**720 by 480**] lines <**Insert resolution**>.
3. Modes: Auto, manual, and alarm. In manual mode, each channel can also be viewed in single display mode. In the event of an alarm, alarming channel is to automatically switch to full screen. If several alarms are activated, channels in alarm are to be in auto-switching mode.
4. Channel Loss Alarm: Audible buzzer; occurrence details are to be recorded.
5. Time: Indicate date and time.
6. Timing of Auto-Switcher: 1 to 30 seconds, selectable.
7. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E, or freestanding desktop.

D. Manual Switch Bank: Low-loss, high-isolation, multiple-video switch to allow manual switching of multiple quad switches and cameras to a single output. Switches are to be illuminated.

E. Sequential Switchers: Automatically sequence outputs of multiple cameras to single monitor and videotape recorder.

1. Switching Time Interval: Continuously adjustable, 5 to 20 seconds minimum, with manual override.
2. Skip-Sequential-Hold Switch: One for each camera, with LED to indicate active camera.
3. Camera Identification Legend: Either on-screen message or label at skip-sequential switch.
4. Alarm Switching: In the event of an alarm, alarming channel is to automatically switch the monitor to full screen.
5. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E.

F. PTZ Controls: Arranged for multiple-camera control, with switches to select camera to be controlled.

1. Pan-and-Tilt Control: Joystick type.
2. Zoom Control: Momentary-contact, "in-out" push button.
3. Automatic-Scan Control: A push button for each camera with pan capability that places camera in automatic-scanning mode.

2.15 IP VIDEO SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Salient Systems Inc.**]
17. [**Samsung Opto-Electronics**]
18. [**SANYO North America Corporation**]
19. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
20. [**Vicon Industries, Inc**]
21. [**VIVOTEK Inc.**]
22. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Dedicated Microcomputers Limited**]
7. [**Elbex Ltd.**]
8. [**EverFocus Electronics Corporation**]
9. [**Hitachi Cable America Inc.**]
10. [**Honeywell Commercial Security; Honeywell International, Inc.**]
11. [**Ikegami Electronics (USA) Inc**]
12. [**Interlogix; Carrier Global Corporation**]
13. [**JVC Americas Corp.**]
14. [**Panasonic Corporation of North America**]
15. [**Pelco**]
16. [**Salient Systems Inc.**]
17. [**Samsung Opto-Electronics**]
18. [**SANYO North America Corporation**]
19. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
20. [**Vicon Industries, Inc**]
21. [**VIVOTEK Inc.**]
22. <**Insert manufacturer's name**>

C. Description:

1. System is to provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
2. System is to have seamless integration of all video surveillance and control functions.

3. Graphical user interface software is to manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system is to also be capable of integrating into larger system environments.
4. System design is to include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit is to provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
5. All camera signals are to be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
6. Camera system units are to be ruggedly built and designed for extreme adverse environments, complying with UL 50E Type environmental standards.
7. Encoder/decoder combinations are to place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
8. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices are to be provided for full performance of specified system.

2.16 VIDEO MOTION SENSORS (INTERIOR)

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**ICU Security, Inc**]
3. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
4. [**Visiontech**]
5. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**ICU Security, Inc**]
3. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
4. [**Visiontech**]
5. <**Insert manufacturer's name**>

C. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs are to be composite video as defined in SMPTE 170M. Provide an alarm output for each video input.

1. Detect movement within protected zone of intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of two. Reject all other changes in video signal.
2. Modular design that allows for expansion or modification of number of inputs.
3. Controls:

    a. Size of detection zones.
    b. Sensitivity of detection of each protected zone.

4. Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E.

2.17 CONTROL STATIONS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Elbex Ltd.**]
7. [**Honeywell Commercial Security; Honeywell International, Inc.**]
8. [**Interlogix; Carrier Global Corporation**]
9. [**Panasonic Corporation of North America**]
10. [**Pelco**]
11. [**Samsung Opto-Electronics**]
12. [**SANYO North America Corporation**]
13. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
14. [**Vicon Industries, Inc**]
15. <**Insert manufacturer's name**>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1. [**AXCESS International Inc.**]
2. [**Bosch Security Systems, Inc.**]
3. [**CBC (AMERICA) Corp**]
4. [**COP-USA**]
5. [**Crest Electronics, Inc**]
6. [**Elbex Ltd.**]
7. [**Honeywell Commercial Security; Honeywell International, Inc.**]
8. [**Interlogix; Carrier Global Corporation**]
9. [**Panasonic Corporation of North America**]
10. [**Pelco**]
11. [**Samsung Opto-Electronics**]
12. [**SANYO North America Corporation**]
13. [**Tyco Security Products; brand of Johnson Controls International plc, Building Solutions North America**]
14. [**Vicon Industries, Inc**]
15. <**Insert manufacturer's name**>

C. Description: Heavy-duty, freestanding, modular, metal furniture units arranged to house electronic equipment. Coordinate component arrangement and wiring with components and wiring of other systems.

D. Equipment Mounting: Standard **19 inch (483 mm)** rack complying with CEA 310-E.

E. Normal System Power Supply: 120 V, 60 Hz, through a locked disconnect device and an isolation transformer in central-station control unit. Central-station control unit is to supply power to all components connected to it unless otherwise indicated.

F. Power Continuity for Control Station: Batteries in power supplies of central-station control units and individual system components are to maintain continuous system operation during outages of both normal and backup ac system supply.

1. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portions of system served including audible trouble signal devices for up to four hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger is to recharge fully discharged battery within 24 hours.

G. Annunciation: Indicate change in system condition and switching of system or component to backup power.

2.18 SIGNAL TRANSMISSION COMPONENTS

A. Cable: Coaxial cable elements have 75 Ω nominal impedance. Comply with requirements in Section 26519 "Low-Voltage Electrical Power Conductors and Cables."

B. Video Surveillance Coaxial Cable Connectors: BNC type, 75 Ω. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

A. Comply with requirements in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Install cables in raceways unless otherwise indicated.

1. Except raceways are not required in accessible indoor ceiling spaces and attics.
2. Except raceways are not required in hollow gypsum board partitions.
3. Conceal raceways and wiring except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. For communication wiring, comply with the following:

1. Section 271313 "Communications Copper Backbone Cabling."
2. Section 271323 "Communications Optical Fiber Backbone Cabling."
3. Section 271333 "Communications Coaxial Backbone Cabling."
4. Section 271513 "Communications Copper Horizontal Cabling."
5. Section 271523 "Communications Optical Fiber Horizontal Cabling."
6. Section 271533 "Communications Coaxial Horizontal Cabling."

F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.3 INSTALLATION OF VIDEO SURVEILLANCE

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with **84 inch (2134 mm)** minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections only at the control station.

1. For 12 and 24 V(dc) cameras, connect the coaxial cable shields only at the monitor end.

G. Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems" and Section 270528 "Pathways for Communications Systems."

3.4 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

    a. Prepare equipment list described in "Informational Submittals" Article.
    b. Verify operation of auto-iris lenses.
    c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
    d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object **50 to 75 ft (17 to 23 m)** away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
    e. Set and name all preset positions; consult Owner's personnel.
    f. Set sensitivity of motion detection.
    g. Connect and verify responses to alarms.
    h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Nonconforming Work:

1. Video surveillance system will be considered defective if it does not pass tests and inspections.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**]<**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**]<**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose. Tasks are to include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.

5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**][**Train**] Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 28 20 00 00

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Task	Specification	Specification Description
28 20 00 00	28 10 00 00a	Access Control Software and Database Management
28 21 00 00	28 10 00 00a	Access Control Software and Database Management
28 21 00 00	28 20 00 00	Video Surveillance
28 21 31 00	26 09 23 00	Electrical Power Monitoring
28 21 31 00	28 10 00 00a	Access Control Software and Database Management
28 21 31 00	28 20 00 00	Video Surveillance
28 21 31 00	28 16 11 00	Intrusion Detection

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SECTION 28 40 00 00 - EMERGENCY RESPONDER COMMUNICATIONS ENHANCEMENT SYSTEM ERCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency responder communications enhancement system (ERCES) equipment.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. [**Section 013100 "Project Management and Coordination"**] <**Insert Section number and title**> specifies preinstallation conference procedures.
5. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
6. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
7. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
8. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic[**and wind**] control devices referenced by this Section.
9. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
10. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.
11. Section 284600 "Fire Detection and Alarm" specifies fire-alarm cabling and interfacing ERCES with fire-alarm systems.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.5 DEFINITIONS

A. Backbone: Primary segment of ERCES between donor antenna and distribution cabling.

B. BDA: Bi-directional amplifier.

C. DAS: Distributed antenna system.

D. Downlink: The signal from a base station to portable radios.

E. ERCES: Emergency responder communications enhancement system(s).

F. FCC: Federal Communications Commission.

G. GROL: General Radiotelephone Operator License (FCC).

H. IB-PSC: In-building public safety communications.

I. LTE: Long-term evolution (mobile device technology standard).

J. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers (NSPE).

K. RF: Radio frequency.

L. UHF: Ultra-high frequency.

M. Uplink: The signal from a portable radio to the base station.

1.6 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals:

1. Engage qualified RF design professional to design ERCES.
2. Engage qualified electrical professional engineer to design power distribution for ERCES.
3. Engage qualified structural professional engineer to design poles, foundations, hangers, and supports for ERCES.
4. Engage qualified fire-alarm system designer for supervision of ERCES components by the building fire-alarm system.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**the Project site**] <**Insert location**>.

B. Preinstallation Coordination Meeting(s): Conduct meeting(s) [**as videoconference**] [**or**] [**at the Project site**] <**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**] [**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.8 ACTION SUBMITTALS

A. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, electrical characteristics, and furnished accessories.
3. <**Insert product-specific submittal data requirement**>.
4. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

    a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
    b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
    c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

5. Include manufacturer's sample extended warranty language.
6. Product Certificates: Include product certificate stating compliance with NFPA 72, NFPA 1225, and specified requirements, signed by manufacturer or fabricator.
7. <**Insert requirements**>.

B. Shop Drawings: Prepare and submit the following:

1. ERCES Drawings, Diagrams, and Supporting Documents:

    a. Project general notes.
    b. Include plans, elevations, sections, details, and attachments to other Work.
    c. Device layout.
    d. Block diagrams and cable/conduit routing.
    e. Cable type identification.
    f. Pathway class and survivability identification.
    g. System communications details.
    h. System sequence of operations.
    i. System mounting details.
    j. Roof attachment and penetration details.
    k. Secondary power calculations.
    l. Critical Areas Coverage: Fire command center, fire pump room, exit stairs/passageways, elevators, elevator lobbies, sprinkler standpipe closets and sectional valves locations, and other areas deemed critical by authorities having jurisdiction.

2. Include lightning protection with donor antenna installation as required by adopted codes and standards and in accordance with manufacturers' instructions. <**Insert additional requirements for drawing content or format**>.

C. Delegated Design Submittals: Include analysis data signed by delegated design professional(s) responsible for their preparation. Include FCC GROL license or IB-PSC certification information.

D. Field quality-control reports.

1.9 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Baseline Radio Signal Strength and Quality Testing Report:

1. Detailed report indicating NFPA 1225 plotted interior radio signal strength or delivered audio quality score throughout building critical and general areas with construction of interior partitions and doors completed, but without ERCES installed.
2. Approval from authorities having jurisdiction to omit ERCES installation within building areas where baseline radio signal strength testing demonstrates that minimum required radio signal strength values are provided within these areas.

C. System Record of Inspection and Testing: Record copy of completed system acceptance testing.[**Format must be approved by authorities having jurisdiction.**]

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for voltage monitoring and adjusting.
4. Field reports for infrared scanning.
5. Field reports for software and firmware upgrades.

1.10 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

C. Software and firmware service agreement.

1.11 REGULATORY AGENCY APPROVALS

A. Submittals for ERCES requiring approval by authorities having jurisdiction must be signed by qualified FCC GROL licensee, NICET IB-PSC design technician, or life-safety professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect**] [**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction**].

B. Submittals for ERCES must include written authorization from the frequency license holder to operate the two-way emergency responder communications enhancement system identified in the submittal.

1.12 QUALIFICATIONS

A. In-Building Public Safety Communications (IB-PSC) Technician Trainee: Having at least six months of experience and possessing active NICET IB-PSC Level I certification. Able to install passive and active ERCES equipment under direct supervision.

B. In-Building Public Safety Communications (IB-PSC) Associate Engineering Technician: Having at least two years of experience and possessing active NICET IB-PSC Level II certification. Able to conduct surveys, to install, to commission, and to maintain ERCES systems under limited supervision.

C. In-Building Public Safety Communications (IB-PSC) Engineering Technician: Having at least five years of experience and possessing active NICET IB-PSC Level III certification. Able to interpret and evaluate surveys, to layout, and to manage ERCES systems without supervision.

D. In-Building Public Safety Communications (IB-PSC) Design Technician: Having at least two years of IB-PSC design experience and possessing active NICET IB-PSC Design Technician certification. Able to prepare shop drawing plans and details for ERCES in accordance with Project requirements, manufacturer's published instructions, site survey data, and design tools.

E. General Radiotelephone Operator License (GROL) Designer: Having an active FCC Registration Number (FRN). Able to prepare shop drawing plans and details for ERCES in accordance with Project requirements, manufacturer's published instructions, site survey data, and design tools.

F. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Training and manufacturer certification to install, splice, and terminate communications cabling.
2. Installation Supervisor: BICSI Technician (TECH) certification.
3. Copper Installers: [**30 percent**] <**Insert quantity**> of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
4. Fiber Installers: [**30 percent**] <**Insert quantity**> of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

G. Communications Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**] <**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**] <**Insert code enforced by authorities having jurisdiction**> testing standards.

H. Life-Safety Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in life-safety systems.

1.13 WARRANTY FOR ERCES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed ERCES perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**] [**Three**] [**Four**] <**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that ERCES perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**] [**Four**] [**Five**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for materials only, free on board [**origin**] [**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Description: The emergency responder communications enhancement system consists of one or more of the following: donor antenna, backbone riser cable, bi-directional amplifier (BDA), coupler, splitter, power divider, and distribution antenna. <**Insert brief description of actual system, assembly, or equipment to be installed**>.

B. Performance Criteria:

1. Regulatory Requirements:

a. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

b. Unless otherwise indicated in Contract Documents, products must comply with NFPA 1, NFPA 70, NFPA 72, NFPA 1225, [**NFPA 101,**] [**ICC IBC,**] [**ICC IFC,**] and local regulations enforced by authorities having jurisdiction.
c. Performance objectives include downlink signal sufficient to provide a minimum of DAQ 3.0 (delivered audio quality) for voice communications using either narrowband, analog, or digital P25 signals or wideband LTE digital signals throughout the coverage area. Recommended design to DAQ 3.4 for safety factor.
d. Uplink signal should be sufficient to provide a minimum of DAQ 3.0 (delivered audio quality) for voice communications using either narrowband, analog, or digital P25 signals or widespread LTE digital signals.

2. General Characteristics: ERCES to be installed inside of buildings using approved materials, electrical and radio components, and accepted installation practices. Where required, ensure that systems meet NFPA survivability requirements through the use of fire barrier construction, fireproofing materials, listed cabling, and environmentally rated enclosures. Buildings fully protected by an automatic sprinkler system in accordance with NFPA 13 do not require fire-resistance rating of the backbone cables or backbone cable components.
3. Provide at least two independent and reliable primary and secondary power sources for all RF-emitting devices and other electronic components of the system.
4. To maintain proper alignment with the donor site, permanently affix donor antennas on the building or mount on a moveable sled with visible signage. Where donor antennas exist, maintain isolation between the donor antenna and all inside antennas to a minimum of 20 dB above system gain. The antenna installation must meet applicable codes for weather protection of the building envelope. Additionally, systems must be protected by lightning protection complying with NFPA 1225.

a. <**Insert additional performance requirements for the Project**>.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**].
2. Component Importance Factor (I_p): [**1.0**] [**1.5**].
3. Component Amplification Factor (a_p): [**1.0**] [**2.5**] <**Insert value**>.
4. Component Response Modification Factor (R_p): [**1.5**] [**2.0**] [**2.5**] [**6.0**] <**Insert value**>.
5. Component Overstrength Factor (Ω_o): [**1.5**] [**2.5**] <**Insert value**>.

2.4 PASSIVE AND ACTIVE SYSTEMS

A. Description: A distributed antenna system (DAS) is one element of an ERCES and does not include an RF signal source such as a BDA or radio base station. The RF distribution part of the system may be either a passive DAS or an active DAS. A passive DAS includes a BDA feeding a coax distribution antenna system through splitters where none of the elements (coax, splitters, antennas) are powered. An active DAS uses powered components to distribute RF signals. A fiber DAS is an example of an active DAS; the head-end device converts RF signals into optical wavelengths sent over the fiber cables. Remote components convert the optical wavelengths back into RF signals and amplify them for broadcast over the distribution antenna system. The head-end device and remote components are powered devices.

2.5 EMERGENCY RESPONDER COMMUNICATIONS ENHANCEMENT SYSTEM (ERCES) EQUIPMENT

A. Description: This category includes in-building ERCES equipment to improve wireless communication. This FCC-certified enhancement system is inclusive of BDAs, transmission lines, cables, power supplies, antennas, and other ancillary equipment that allow radio signals to pass to and from interior of structure for facilitating radio communications using emergency responder radio frequencies.

B. In-Building ERCES Bi-Directional Amplifiers <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. ERCES: UL CCN UTMH; including UL 2524 and NFPA 1225.

3. Standard Features:

    a. Primary Power Supply: [**120 V(ac)**] [**240 V(ac)**] <**Insert voltage**> supplied from a dedicated branch circuit, permanently connected, protected from overvoltage, and NFPA 72 compliant.
    b. Secondary Power Supply: Provide one of the following:

        1) [**24 V(dc)**] <**Insert voltage**> supplied from a storage battery with capacity of 12 h at 100 percent system operation capacity.
        2) Power source with capacity of 12 h at 100 percent system operation capacity approved by authorities having jurisdiction.
        3) 2 h battery supplemented by a generator power system with capacity to support system load for 12 h.

    c. Monitor the integrity of power sources in accordance with NFPA 1225.
    d. Supervision: Provide auxiliary contacts for remote status supervision by [**protected premises fire-alarm system**] [**mass notification system**] <**Insert system**>.

        1) Signal booster failure.
        2) Antenna malfunction.
        3) Loss of normal AC power.
        4) Low battery voltage.
        5) Battery charger failure.
        6) <**Insert system status supervision**>.

    e. Monitor system integrity in accordance with Ch. 10 of NFPA 72. Monitor integrity of the communications link between the [**protected premises fire-alarm system**] [**mass notification system**] <**Insert system**> and the in-building ERCES. Where approved by authorities having jurisdiction, a single supervisory input is permitted to the [**protected premises fire-alarm system**] [**mass notification system**] <**Insert system**>.
    f. Cabinet Enclosures: UL 50E, [**Type 4**] [**Type 3R**]. Protect battery systems with a Type 3R or higher-rated cabinet. Protect repeater, transmitter, receiver, signal booster components, optical-to-RF converters, and external filters with a Type 4 or Type 4X enclosure.
    g. Mounting: [**Surface**] <**Insert type**> mount.
    h. Finish: [**Factory-finish red enamel**] <**Insert finish**>.

4. Options:

a. Remote Indicator Panel: As required. Install remote indicator panel within the fire command center or at a location designated by authorities having jurisdiction, and in accordance with approved shop drawings showing location, mounting height, and wiring detail. The indicator panel must display the following:

1) Presence of primary AC power.
2) Loss of primary AC power.
3) Battery charger failure.
4) Low-battery capacity.
5) Signal source malfunction.
6) Active RF-emitting device malfunction.
7) Active system component malfunction.

b. Emergency Power-Off (EPO) Switch: As required. The EPO switch interrupts power to the ERCES on direction from authorities having jurisdiction or frequency license holder.

C. In-Building ERCES Distributed Antennas <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard Features:

a. Type: [**Wide-band omnidirectional**] [**and**] [**multi-band**] [**single-band**].
b. Mounting: Low-profile [**ceiling**] <**Insert type**> mount.

D. In-Building ERCES Donor Antennas <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard Features:

a. Configuration: Factory-assembled and -tuned directional UHF Yagi antenna.
b. Mounting: [**Stainless steel**] <**Insert type**> mounting hardware.
c. Finish: [**Welded**] [**or**] [**seamless**] corrosion-resistant aluminum construction.
d. Wind Velocity Rating: [**Comply with minimum ICC IBC requirements**] <**Insert requirements**>.

E. RF Antenna Cable Couplers and Splitters <**Insert drawing designation**>:

1. Description: Physical hardware elements connecting the donor antenna cables to the distributed antennas, mounting hardware, and building elements.
2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
3. Standard Features:

a. Configuration: Nominal [**0.5 inch (13 mm)**] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**>, N-Type, weatherproof, medium-size, RF couplers, and splitters for coaxial cables.
b. Bandwidth: [**As required by in-building emergency radio enhancement system performance requirements**] <**Insert requirement**>.
c. Gain (dB) Rating: [**As required by in-building emergency radio enhancement system performance requirements**] <**Insert requirement**>.
d. Environmental Rating: [**Type 4 and][IP65**] <**Insert IP code**>.

F. Remote Indicator Panel <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standard Features:

   a. Primary Power Supply: [**24 V(dc)**] [**120 V(ac)**] generally powered from the ERCES power supply as auxiliary nominal 28 V(dc). <**Insert voltage**>.
   b. Secondary Power Supply: Provide one of the following:

      1) [**24 V(dc)**] <**Insert voltage**> storage battery with capacity for 12 h at 100 percent system operation capacity.
      2) Power source with capacity for 12 h at 100 percent system operation capacity approved by authorities having jurisdiction.
      3) 2 h battery supplemented by standby generator power system with capacity to support system load for 12 h.

   c. Configuration: Zone indicator panel with LED indicators[**, piezoelectric sounder,**] and switches for lamp test and alarm silence.
   d. LED Indicators: Green indicator for primary power in normal state; red indicators for each individual fault status required to be indicated by authorities having jurisdiction.
   e. Enclosure: [**16-gauge steel**] <**Insert material**> with factory-applied red enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF EMERGENCY RESPONDER COMMUNICATIONS ENHANCEMENT SYSTEM (ERCES)

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Temporary Electric Power Work: NECA NEIS 200.
5. Commissioning of Electrical Systems: NECA NEIS 90.
6. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
7. Hot Work: NFPA 51B.
8. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, NFPA 1225, and NECA NEIS 305.
9. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
10. Communications Work: BICSI N1.
11. Work in ITE Rooms: NFPA 75.
12. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
13. Life-Safety and Means-of-Egress Work: NFPA 101.
14. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
15. Work in Confined Spaces: NFPA 350.
16. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
17. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
18. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
19. Fire-Alarm Circuits and Pathways: Ch. 12 of NFPA 72 and Article 760 of NFPA 70.
20. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Installation for Survivability:

    a. Install cables in accordance with Ch. 7 and 8 of NFPA 70.
    b. Provide mechanical protection of work and raceways for coax cables in accordance with Article 820 of NFPA 70.
    c. Backbone cables and cable components installed in buildings that are fully protected by an automatic sprinkler system in accordance with NFPA 13 do not require fire-resistance rating.
    d. Protect backbone cables and cable components installed in nonsprinklered buildings, in buildings that are partially protected by an automatic sprinkler system, or in high-rise buildings from attack by fire in accordance with one of the following:

        1) Provide cable with listed fire-resistance rating in accordance with the following criteria:

            a) Where the primary structural frame of a building is required to have a fire-resistance rating of 2 h or more, or is classified as heavy-timber construction, provide minimum 2 h fire-resistance rated cable.
            b) Where the primary structural frame of a building is required to have a fire-resistance rating of less than 2 h, provide minimum 1 h fire-resistance rated cable.
            c) Where the primary structural frame of a building does not require a fire-resistance rating, fire-resistance rated cable is not required.

        2) Provide protected enclosure or area with fire-resistance rating in accordance with the following criteria:

            a) Where the primary structural frame of a building is required to have a fire-resistance rating of 2 h or more, or is classified as heavy-timber construction, provide minimum 2 h fire-resistance rated enclosure or area.
            b) Where the primary structural frame of a building is required to have a fire-resistance rating of less than 2 h, provide minimum 1 h fire-resistance rated enclosure or area.
            c) Where the primary structural frame of a building does not require a fire resistance rating, fire-resistance rated enclosure or area is not required.

    e. Where the backbone cables and distribution antenna cables are run in a fire-resistant enclosure or protected area, both of the following shall apply, except as permitted in Section 18.12.3.6 of NFPA 1225:

        1) Provide connection between backbone cable and distribution antenna cables within an enclosure or protected area in accordance with Section 18.12.3.4 of NFPA 1225, Section 18.12.3.4.
        2) Provide firestop assembly for passage of the distribution antenna cable in and out of the enclosure or protected area with equivalent rating to enclosure or protected area.

    f. If both the backbone cables and cable components are fire rated in accordance with Section 18.12.3.4 of NFPA-1225, connection of the distribution antenna cable may be made outside enclosure or protected area.

2. Antenna Wiring Methods:

    a. Coaxial Cabling:

1) Riser Coaxial Cable: Type CATVR, nominal [0.5 inch (13 mm)] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**> coaxial jacketed cable with corrugated [**copper**] [**or**] [**aluminum**] outer conductor.
2) Plenum Coaxial Cable: Type CATVP, nominal [0.5 inch (13 mm)] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**> coaxial jacketed cable with corrugated [**copper**] [**or**] [**aluminum**] outer conductor.
3) Plenum Radiating Coaxial Cable: Type CATVP, nominal [0.5 inch (13 mm)] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**> radiating coaxial jacketed cable with corrugated [**copper**] [**or**] [**aluminum**] outer conductor.
4) Connectors: Nominal [0.5 inch (13 mm)] <**Insert diameter**>, [**50 Ω**] <**Insert impedance**> N-Type, weatherproof, medium-size, RF connectors for coaxial cables.

3. Determine in-building service antenna locations based on baseline radio signal strength testing.
4. Request approval from authorities having jurisdiction to omit emergency responder radio coverage system from areas of building where baseline radio signal strength testing demonstrates that minimum required radio signal strength values are achieved without radio coverage system.
5. Install outdoor donor antenna with clear view to donor site with minimum [2 ft (0.6 m)] vertical clearance above nearby obstacles.
6. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturer's published instructions**>.

D. Interfaces with Other Work:

1. Coordinate with Section 284600 "Fire Detection and Alarm" for interfaces with fire-alarm system.
2. Identification: Provide labels for ERCES and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3. Coordinate installation of new products for <**Insert system or product group/category**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

4. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

E. Systems Integration:

1. <**Insert requirements for integration with other systems**>.

3.2 FIELD QUALITY CONTROL OF ERCES

A. Administrant for Communications Tests and Inspections:

1. [**Owner**] [**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**] [**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. Notify the Owner and authorities having jurisdiction no later than ten working days in advance of scheduled acceptance testing of the installed system.
2. Notify the frequency license holder no later than ten working days in advance of scheduled testing of the installed system. Receive written authorization from the frequency license holder to activate active RF components on scheduled date.
3. Provide Owner and authorities having jurisdiction with a written test plan no later than seven working days prior to conducting acceptance tests.

D. Field tests and inspections must be witnessed by [**Architect**] [**Tenant**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform standard field tests and inspections as required by NFPA 72 for fire-alarm supervision of ERCES components.
3. Perform standard field tests and inspections as required by NFPA 1225.
4. Building Owner to have the ERCES inspected and tested annually or where structural changes occur, including additions or remodels.
5. Baseline radio signal strength testing.
6. <**Insert detailed description of additional tests and inspections required**>.

F. Nonconforming Work:

1. ERCES will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.3 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**] [**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 CLOSEOUT ACTIVITIES

A. Training:

1. [**With assistance from factory-authorized service representatives, train**] [**Train**] Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain ERCES components.
b. <**Insert system or equipment**>.

2. [**Provide video recordings of training sessions to Owner**] [**Allow Owner to record training sessions**].

3.5 PROTECTION

A. After installation, protect ERCES equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three-month**] [**six-month**] [**nine-month**] [**one-year**] <**Insert duration**> period for full maintenance by [**skilled employees of ERCES Installer**] [**manufacturer's authorized service representative**]. Include [**monthly**] [**quarterly**] [**semiannual**] [**annual**] preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper ERCES operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

B. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two years**] <**Insert duration**>.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two years**]

<**Insert duration**> from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

a. Upgrade Notice: Not less than [**30 days**] <**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 28 40 00 00

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Task	Specification	Specification Description
28 40 00 00	28 10 00 00a	Access Control Software and Database Management
28 41 00 00	28 10 00 00a	Access Control Software and Database Management
28 41 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 41 15 00	28 10 00 00a	Access Control Software and Database Management
28 41 15 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 42 00 00	28 10 00 00a	Access Control Software and Database Management
28 42 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 42 11 00	28 10 00 00a	Access Control Software and Database Management
28 42 11 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 42 15 00	28 10 00 00a	Access Control Software and Database Management
28 42 15 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 43 00 00	28 10 00 00a	Access Control Software and Database Management
28 43 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES

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SECTION 28 46 00 00 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm system control units.
2. Dedicated function control units.
3. Fire-alarm remote annunciators.
4. Fire-alarm auxiliary power supplies.
5. Fire-alarm audio amplifiers.
6. Fire-alarm terminal cabinets.
7. Manual fire-alarm boxes.
8. Heat-sensing fire detectors.
9. Smoke-sensing fire detectors.
10. Radiant energy-sensing fire detectors.
11. Combination, multi-criteria, and multi-sensor detectors.
12. Carbon monoxide detectors.
13. Sprinkler waterflow alarm-initiating devices.
14. Audible notification appliances.
15. Visual notification appliances.
16. Combination audible/visual notification appliances.
17. Firefighters' two-way, in-building wired telephone communications system.
18. Fire-alarm supervised control module interfaces for fire safety functions.
19. Fire-alarm supervisory signal-initiating devices.
20. Fire-alarm digital alarm communicator transmitters.
21. Fire-alarm radio alarm transmitters.
22. Fire-alarm record documentation cabinets.
23. Passive graphic maps.
24. Fire-alarm cables.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
5. [**Section 087100 "Door Hardware"**][**Section 087111 "Door Hardware (Descriptive Specification)"**][**Section 087113 "Power Door Operators"**][**Section 087813 "All-Glass-Entrance Hardware"**] specifies door hardware control interfaces referenced by this Section.
6. [**Section 142100 "Electric Traction Elevators"**][**Section 142113 "Electric Traction Freight**

Elevators"][**Section 142123.16 "Machine Room-Less Electric Traction Passenger Elevators"**][**Section 142400 "Hydraulic Elevators"**][**Section 142413 "Hydraulic Freight Elevators"**][**Section 142600 "Limited-Use/Limited-Application Elevators"**] specifies elevator control interfaces referenced by this Section.

7. Section 143100 "Escalators" specifies escalator control interfaces referenced by this Section.
8. Section 143200 "Moving Walks" specifies moving walk control interfaces referenced by this Section.
9. Section 230923 "Direct Digital Control (DDC) System for HVAC" specifies HVAC control interfaces referenced by this Section.
10. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
11. Section 260533.13 "Conduits for Electrical Systems" specifies raceway types installed by this Section.
12. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic[**and wind**] control devices referenced by this Section.
13. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
14. Section 260923 "Lighting Control Devices" specifies emergency lighting control interfaces referenced by this Section.
15. Section 262816 "Enclosed Switches and Circuit Breakers" specifies shunt-trip control interfaces referenced by this Section.
16. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.
17. Section 275119 "Sound Masking Systems" specifies sound masking system equipment referenced by this Section.
18. Section 284700 "Mass Notification" specifies mass notification system interfaces referenced by this Section.
19. Section 284800 "Emergency Response Systems" specifies [**ERCES**][**and**][**two-way emergency communications systems for rescue assistance**] referenced by this Section.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. AWG: American wire gauge; see ASTM B258.
2. BAS: Building automation system.
3. BMS: Building management system.
4. cd: Candela, the SI fundamental unit of luminous intensity.
5. DACR: Digital alarm communicator receiver.
6. DACT: Digital alarm communicator transmitter.
7. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
8. EMP: Electrical maintenance program (operation and maintenance); electromagnetic pulse (transient analysis).
9. EPS: Emergency power supply.
10. EPSS: Emergency power supply system.
11. ERCES: Emergency responder communications enhancement system.
12. ESS: Energy storage system.
13. FACU: Fire-alarm control unit.
14. FAS: Fire-alarm system.
15. IDC: Initiating device circuit.
16. IP: Internet Protocol.
17. IR: Infrared.

18. LAN: Local area network.
19. LCD: Liquid-crystal display.
20. LED: Light-emitting diode.
21. Li-ion: Lithium-ion.
22. NAC: Notification appliance circuit.
23. N.C.: Normally closed.
24. Ni-Cd: Nickel-cadmium.
25. Ni-MH: Nickel-metal hydride.
26. N.O.: Normally open.
27. PC: Personal computer.
28. PLFA: Power-limited fire alarm.
29. PoE: Power over Ethernet.
30. POTS: Plain old telephone service. See "public switched telephone network" definition.
31. PSTN: Public switched telephone network.
32. RAT: Radio alarm transmitter.
33. SLC: Signaling-line circuit.
34. TR: Tamper resistant.
35. UL: (standards) UL Standards & Engagement Inc.; (product categories) UL Solutions, Inc.
36. UL CCN: UL Category Control Number.
37. UPS: Uninterruptible power supply.
38. VoIP: Voice over Internet Protocol.
39. VPN: Virtual private network.
40. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
41. WAN: Wide area network.
42. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ERMC-A: Aluminum electrical rigid metal conduit.
6. ERMC-S: Steel electrical rigid metal conduit.
7. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
8. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
9. ERMC-SS: Stainless steel electrical rigid metal conduit.
10. FMC: Flexible metal conduit.
11. FMC-A: Aluminum flexible metal conduit.
12. FMC-S: Steel flexible metal conduit.
13. IMC: Steel electrical intermediate metal conduit.
14. LFMC: Liquidtight flexible metal conduit.
15. LFMC-A: Aluminum liquidtight flexible metal conduit.
16. LFMC-S: Steel liquidtight flexible metal conduit.
17. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
18. LFNC: Liquidtight flexible nonmetallic conduit.
19. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
20. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
21. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
22. PVC: Rigid PVC conduit.
23. PVC-40: Schedule 40 rigid PVC conduit.
24. PVC-80: Schedule 80 rigid PVC conduit.
25. RGS: See ERMC-S-G.
26. RMC: See ERMC raceway types above.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. CI: Circuit integrity cable.
2. FPL: Power-limited fire-alarm cable.
3. FPLP: Power-limited fire-alarm plenum cable.
4. FPLR: Power-limited fire-alarm riser cable.
5. MC-FPL/FPLR/FPLP: Metal-clad cable containing FPL, FPLR, or FPLP.
6. NPLF: Non-power-limited fire-alarm circuit cable.
7. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
8. NPLFR: Non-power-limited fire-alarm circuit riser cable.
9. OFC: Conductive optical fiber general-purpose cable.
10. OFCG: Conductive optical fiber general-purpose cable.
11. OFCP: Conductive optical fiber plenum cable.
12. OFCR: Conductive optical fiber riser cable.
13. OFN: Nonconductive optical fiber general-purpose cable.
14. OFNG: Nonconductive optical fiber general-purpose cable.
15. OFNP: Nonconductive optical fiber plenum cable.
16. OFNR: Nonconductive optical fiber riser cable.

D. Definitions:

1. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
2. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
3. Conduit: A structure containing one or more duct raceways.
4. Designated Seismic System: An architectural, electrical, or mechanical system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."
5. Direct Buried: Installed underground without encasement in concrete or other protective material.
6. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
7. Duct Raceway: A single enclosed raceway for conductors or cable.
8. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
9. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted pair cables from a telephone-provider central office for the transmission medium. "PSTN" refers to the telephone network; "POTS" refers to the individual subscriber line.
10. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.
11. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For fire-alarm system coordination with [**sound-masking system**][**paging system**][**and**][**mass notification system**]. Conduct meeting(s) [**as videoconference**][**or**][**at Project site**]<**Insert location**> before <**Insert construction activity**>.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect[**, Construction Manager**][**, and Owner's Commissioning Authority**] of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are not acceptable for submitted product.

2. Include manufacturer's sample extended warranty language.
3. <**Insert requirements**>.

B. Shop Drawings: Prepare and submit the following:

1. Cover sheet indicating protected premises name and location and Owner information, name of installer, device legend and symbols [**in accordance with NFPA 170**][**acceptable to the authorities having jurisdiction**], and date of issue and any revision dates.
2. Floor Plans:

a. Floor or level identification.
b. Point of compass (indication of north).
c. Graphic scale.
d. All walls and doors.
e. All partitions extending to within 15 percent of the ceiling height.
f. Room and area descriptions.
g. Acoustically distinguishable spaces.
h. Minimum required illumination levels.
i. System devices/component locations.
j. Locations of the system's primary power disconnecting means.
k. Locations of monitor/control interfaces to other systems.
l. System riser locations.
m. Type and number of system components/devices on each circuit, on each floor or level.
n. Type and quantity of conductors[**and conduit**] for each circuit.
o. Identification of any ceiling over **10 ft (3.0 m)** in height where automatic fire detection is being proposed.
p. Details of ceiling geometries, including beams and solid joists, where automatic fire

detection is being proposed.
q. Acoustic properties of spaces, where known.
r. Pathway class designations, including the location of any end-of-line supervisory or power devices that are required by the pathway class.
s. Pathway survivability level designations.

3. Wiring Diagrams:

a. System riser diagrams coordinated with the floor plans and indicating the following information:

1) General arrangement of the system in building cross-section.
2) Number of risers.
3) Type and number of circuits in each riser.
4) Type and number of system components/devices on each circuit, on each floor or level.
5) Number of conductors for each circuit.
6) Pathway class designation, including the location of any end-of-line supervisory or power devices that are required by the pathway class.
7) Pathway survivability level designations.

b. Control unit diagrams for all control equipment, power supplies, battery chargers, and annunciators indicating the following information:

1) Identification of control equipment depicted.
2) Location(s) of control equipment.
3) All field wiring terminals and terminal identifications.
4) All circuits connected to field wiring terminals and circuit identifications.
5) All indicators and manual controls.
6) Field connections to supervising station signaling equipment[**, releasing equipment,**] and emergency safety control interfaces.

c. Typical fire-alarm component schematic wiring diagrams for all initiating devices, notification appliances,[**remote indicators,**][**remote test stations,**][**end-of-line and power supervisory devices,**] and annunciators.

4. Fire-Alarm Input/Output Sequence: Include a narrative description or input/output matrix of operation to describe the fire-alarm system sequence of operation.
5. Details:

a. Component installation details.
b. Custom graphic annunciator layout.

6. Calculations:

a. Battery calculations.
b. Voltage-drop calculations.
c. Speaker circuit calculations.
d. Spare capacity circuit calculations.

C. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for [**software**][**and**][**firmware**] upgrades.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

B. Maintenance service agreement.

C. Software and firmware service agreement.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.8 REGULATORY AGENCY APPROVALS

A. Submittals for fire detection and alarm system requiring approval by authorities having jurisdiction must be signed by qualified NICET FAS[**senior**] engineering technician or life-safety professional engineer responsible for their preparation.[**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**][**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.9 QUALIFICATIONS

A. Fire-Alarm Systems (FAS) Technician Trainee: Having at least six months of experience and possessing active NICET FAS Level I certification. Able to perform limited tasks under direct supervision.

B. Fire-Alarm Systems (FAS) Associate Engineering Technician: Having at least two years of experience and possessing active NICET FAS Level II certification. Able to review drawings, specifications, codes, and standards; to conduct basic installation activities; and to perform basic troubleshooting.

C. Fire-Alarm Systems (FAS) Engineering Technician: Having at least five years of experience and possessing active NICET FAS Level III certification. Able to perform system layout activities, supervise Level I and Level II technicians, provide submittal packages, and interact with authorities having jurisdiction.

D. Fire-Alarm Systems (FAS) Senior Engineering Technician: Having at least 10 years of experience and possessing active NICET FAS Level IV certification. Able to manage multiple projects at once, interpret codes and standards, conduct training, and serve as liaison between authorities having jurisdiction, owners, engineers, and contractors.

E. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and prepare related records and reports.

F. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke control interfaces, air sampling systems, multi-zone voice evacuation systems, or high-rise applications) and prepare related records and reports.

G. Life-Safety Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in life-safety systems.

H. Fire-Alarm Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate fire-alarm cabling.

1. On-site fire-alarm cable installation supervisor must possess active NICET FAS[**Senior**] Engineering Technician certification.

I. Fire-Alarm Testing Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician [**I**][**II**] certification.

1.10 WARRANTY FOR FIRE DETECTION AND ALARM SYSTEMS

A. Special Installer Extended Warranty: Installer warrants that installed fire detection and alarm system performs in accordance with specified requirements and agrees to repair or replace system components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**][**Three**][**Four**]<**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that fire detection and alarm system components perform in accordance with specified requirements and agrees to repair or replace system components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**][**Four**][**Five**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**]<**Insert number**> years from date of Substantial Completion; [**full**][**prorated**] coverage for materials[**that failed because of transient voltage surges**] only, free on board [**origin**][**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer and model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70 or NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. System Description: Noncoded, [**UL-certified**][**FM Global-placarded**][**addressable**][**conventional**] system with multiplexed signal transmission and [**voice**][**horn**]-and-strobe notification for evacuation.

C. System Inputs:

1. Fire-alarm signal initiation must be by one or more of the following devices[**and systems**]:

a. Manual fire-alarm boxes.
b. Heat detectors.
c. Smoke detectors.
d. Flame detectors.
e. Duct smoke detectors.
f. Air-sampling smoke-detection system.
g. Carbon monoxide detectors.
h. Combustible gas detectors.
i. Automatic sprinkler system water flow.
j. Preaction system alarm.
k. Fire-extinguishing system operation.
l. Fire standpipe system.
m. Dry-pipe sprinkler system pressure flow switch.
n. Fire pump is running.
o. <**Insert alarm-initiating devices and systems**>.

2. Supervisory signal initiation must be by one or more of the following devices and actions:

a. Valve supervisory switch.

b. High- or low-air pressure switch of dry-pipe or preaction sprinkler system.
c. Alert and Action signals of air-sampling smoke-detection systems.
d. Duct smoke detectors.
e. Elevator shunt-trip control circuit supervision.
f. Independent fire-detection and fire-suppression systems.
g. Fire pump is running.
h. Fire pump has lost power.
i. Power to the fire pump has phase reversal.
j. Zones or individual devices have been disabled.
k. FACU has lost communication with network.
l. Hose cabinet door is open.
m. <**Insert supervisory signal-initiating devices and actions**>.

3. System trouble signal initiation must be by one or more of the following devices and actions:

a. Open circuits, shorts, and grounds in designated circuits.
b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
c. Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, or ethernet module.
d. Loss of primary power at FACU.
e. Ground or single break in internal circuits of FACU.
f. Abnormal AC voltage at FACU.
g. Break in standby battery circuitry.
h. Failure of battery charging.
i. Abnormal position of switch at FACU or remote annunciator.
j. Voice signal amplifier failure.
k. <**Insert trouble signal-initiating devices and actions**>.

4. Carbon monoxide alarm signal initiation must be by the following devices[**and systems**]:

a. Carbon monoxide detectors.

D. System Outputs:

1. Fire-alarm signal must initiate the following actions:

a. Continuously operate alarm notification appliances[**, including voice evacuation notices**].
b. Identify alarm and specific initiating device at FACU[**, connected network control panels, off-premises network control panels,**][**and remote annunciators**].
c. Transmit alarm signal to remote alarm receiving station.
d. Unlock electric door locks in designated egress paths.
e. Release fire and smoke doors held open by magnetic door holders.
f. Activate voice/alarm communication system.
g. Switch HVAC equipment controls to fire-alarm mode.
h. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
i. Activate stairwell[**and elevator-shaft**] pressurization systems.
j. Close smoke dampers in air ducts of designated air-conditioning duct systems.
k. Activate preaction system.
l. Recall elevators to designated or alternate recall levels only upon activation of smoke detectors in respective elevator lobbies, machine rooms, or hoistways.
m. Activate elevator power shunt trip only upon activation of associated heat detector.
n. Activate emergency lighting control.
o. Activate emergency shutoffs for gas and fuel supplies[**, except for shutoffs serving**

legally required life-safety systems such as emergency generators and fire pumps].

p. Record events in system memory.
q. Indicate device in alarm on graphic annunciator.
r. <**Insert signal-initiating actions**>.

2. System supervisory signal must initiate the following actions:

a. Initiate supervisory notification appliances.
b. Identify specific device initiating event at FACU[**, connected network control panels, off-premises network control panels,**][**and remote annunciators**].
c. After time delay of [**200 seconds**]<**Insert time**>, transmit trouble or supervisory signal to remote alarm receiving station.
d. Transmit system status to building management system.
e. Display system status on graphic annunciator.

3. Carbon monoxide alarm signal must initiate the following actions:

a. Initiate carbon monoxide notification appliances and sound temporal-4 signal.
b. Identify specific device initiating event at FACU[**, connected network control panels, off-premises network control panels,**][**and remote annunciators**].
c. Transmit carbon monoxide alarm signal to remote alarm receiving station.

2.4 FIRE-ALARM SYSTEM CONTROL UNITS

A. Description: A component of the fire-alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire-alarm control units, and processes these signals to determine part or all of the required fire-alarm system output functions.

B. UL UOJZ - Addressable Fire-Alarm System Control Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Bosch Security Systems, Inc.**]
b. [**Fike Corporation**]
c. [**Fire-Lite Alarms; Honeywell International, Inc.**]
d. [**Firecom, Inc.**]
e. [**Gamewell-FCI; Honeywell International, Inc.**]
f. [**Keltron Corporation**]
g. [**Kidde Commercial Fire & Life Safety Systems**]
h. [**Kidde; Carrier Global Corporation**]
i. [**Kingfisher Company, Inc.**]
j. [**Notifier; Honeywell International, Inc.**]
k. [**Potter Electric Signal Company, LLC**]
l. [**Siemens Industry, Inc.; Fire Safety Division**]
m. [**Silent Knight; Honeywell International, Inc.**]
n. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
o. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Bosch Security Systems, Inc.**]
b. [**Fike Corporation**]
c. [**Fire-Lite Alarms; Honeywell International, Inc.**]
d. [**Firecom, Inc.**]
e. [**Gamewell-FCI; Honeywell International, Inc.**]
f. [**Keltron Corporation**]
g. [**Kidde Commercial Fire & Life Safety Systems**]
h. [**Kidde; Carrier Global Corporation**]
i. [**Kingfisher Company, Inc.**]
j. [**Notifier; Honeywell International, Inc.**]
k. [**Potter Electric Signal Company, LLC**]
l. [**Siemens Industry, Inc.; Fire Safety Division**]
m. [**Silent Knight; Honeywell International, Inc.**]
n. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
o. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Electrical Control Units for Fire-Protective Signaling Systems: UL CCN UOJZ, including UL 864 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 23 of NFPA 72.
   b. [**Voice**][**Non-voice**]/alarm communications.
   c. Indication of which communication zones have been silenced.
   d. Provide selective silencing of alarm notification appliances by building communication zone.
   e. Real-time clock for time annotation of events on the event recorder[**and printer**].
   f. Communication between the FACU and remote circuit interface panels, annunciators, and displays.
   g. The FACU must be listed for connection to a central station signaling system service.
   h. Provide non-volatile memory for system database, logic, operating system, and event history.
   i. The system must not require manual input to initialize in the event of a complete power-down condition.
   j. Alphanumeric display and system controls.
   k. Minimum of [**two**][**four**]<**Insert number**>[**Class A**][**Class X**][**Class B**] signaling-line circuits[**with expansion capability to add circuits**].
   l. Minimum of [**two**][**four**]<**Insert number**>[**Class A**][**Class B**] notification appliance circuits[**with expansion capability to add circuits**].
   m. Synchronization of notification appliance circuits.

6. Other Available Features Required by Project:

   a. Printer interface.
   b. Smoke-alarm verification.

C. UL UOJZ - Conventional Fire-Alarm System Control Units :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bosch Security Systems, Inc.**]
    b. [**Edwards; Carrier Global Corporation**]
    c. [**Gamewell-FCI; Honeywell International, Inc.**]
    d. [**Notifier; Honeywell International, Inc.**]
    e. [**Siemens Industry, Inc.; Fire Safety Division**]
    f. [**Silent Knight; Honeywell International, Inc.**]
    g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bosch Security Systems, Inc.**]
    b. [**Edwards; Carrier Global Corporation**]
    c. [**Gamewell-FCI; Honeywell International, Inc.**]
    d. [**Notifier; Honeywell International, Inc.**]
    e. [**Siemens Industry, Inc.; Fire Safety Division**]
    f. [**Silent Knight; Honeywell International, Inc.**]
    g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
    h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Electrical Control Units for Fire-Protective Signaling Systems: UL CCN UOJZ, including UL 864 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 23 of NFPA 72.
    b. Communication between devices and control panel is limited and has only three states: Standby, Fault, and Fire.
    c. Minimum of [**four**][**eight**]<**Insert number**> conventional zones to supervise initiating device circuits.
    d. Built-in alarm and trouble relays.
    e. Capable of being interfaced to supervise third-party systems or equipment via dry contact closure.
    f. Synchronization of notification appliance circuits.

6. Other Available Features Required by Project:

    a. Printer interface.

2.5 DEDICATED FUNCTION CONTROL UNITS

A. Description: A protected premises fire-alarm control unit specifically listed for supervising a single function, such as releasing service that is part of a fire-suppression system and which provides control outputs to release a fire-suppression agent based on either automatic or manual input.

B. UL SYZV - Addressable Non-Extinguishing and Non-Water-Based Releasing Device Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Johnson Controls, Inc.**]
    b. [**Silent Knight; Honeywell International, Inc.**]
    c. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Johnson Controls, Inc.**]
    b. [**Silent Knight; Honeywell International, Inc.**]
    c. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
    d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Releasing Device Control Units for Fire-Protective Signaling Systems: UL CCN SYZV, including UL 864 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 23 of NFPA 72.
    b. Built-in alarm, trouble, supervisory, and security relays.
    c. Minimum of [**two**][**four**]<**Insert number**>[**Class A**][**Class X**][**Class B**] signaling-line circuits[**with expansion capability to add circuits**].
    d. Auto programming and walk test reports.
    e. Manual sensitivity adjustments.
    f. Maintenance alerts.
    g. Battery charger supports.
    h. Non-alarm points for lower-priority functions.

6. Other Available Features Required by Project:

    a. Printer interface.
    b. Synchronization of notification appliance circuits.

C. UL SYZV - Conventional Non-Extinguishing and Non-Water-Based Releasing Device Control Unit :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Releasing Device Control Units for Fire-Protective Signaling Systems: UL CCN SYZV, including UL 864 and NFPA 72.

4. Standard Features:

    a. Product Reference Standards: Ch. 23 of NFPA 72.
    b. Built-in alarm and trouble relays.
    c. Minimum of [**two**][**four**]<**Insert number**>[**Class A**][**Class B**] initiating device circuits[**with expansion capability to add circuits**].
    d. Maintenance alerts.
    e. Battery charger supports.

5. Other Available Features Required by Project:

    a. Printer interface.
    b. Synchronization of notification appliance circuits.

2.6 FIRE-ALARM REMOTE ANNUNCIATORS

A. Description: A unit containing one or more indicator lamps, alphanumeric displays, or other equivalent means in which each indication provides status information about a fire-alarm system device, circuit, condition, or location.

B. UL UOXX - Fire-Alarm System Remote Annunciators :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Bosch Security Systems, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Bosch Security Systems, Inc.**]
    b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 23 of NFPA 72.
b. Compatibility with fire-alarm control unit for alphanumeric display and LED indicating lights.
c. Provide controls to acknowledge, silence, reset and test functions for alarm, supervisory, and trouble signals.

2.7 FIRE-ALARM AUXILIARY POWER SUPPLIES

A. Description: An auxiliary source of low-voltage electrical operating power for fire-alarm system equipment, including the circuits and terminations connecting it to the equipment being powered. Auxiliary power supplies are often referred to as remote power supplies, booster power supplies, or notification appliance power supplies.

B. UL UOXX - Fire-Alarm Auxiliary Power Supplies :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Chs. 10 and 23 of NFPA 72.
b. Minimum of [**two**][**four**]<**Insert number**> 24 V(dc) auxiliary power circuits.

5. Other Available Features Required by Project:

a. Synchronization of notification appliance circuits.
b. Addressable-type notification appliance power supply, which connects directly to a signaling-line circuit.

2.8 FIRE-ALARM AUDIO AMPLIFIERS

A. Description: A component of in-building fire emergency voice/alarm communications systems that takes a low-level audio input and amplifies the power output to distribute to fire-alarm loudspeakers. Amplifiers can be an integral component of the fire-alarm control unit or can be remotely located in a separate

cabinet within the building.

B. UL UEAY2 - Fire-Alarm Audio Amplifiers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Cooper Wheelock; brand of Eaton**]
   b. [**Extron Electronics**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Cooper Wheelock; brand of Eaton**]
   b. [**Extron Electronics**]
   c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Amplifiers for Fire-Protective Signaling Systems: UL CCN UEAY2, including UL 1711, UL 1480, UL 1480A, UL 864, and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Chs. 18, 23, and 24 of NFPA 72.
   b. Supervised high-fidelity audio for emergency voice evacuation fire-alarm systems.
   c. Frequency Response: 275 Hz - 6.5 kHz.
   d. Speaker Outputs: [**25 V**][**70 V**] power limited.
   e. Minimum of [**four**][**eight**]<**Insert number**>[**Class A**][**Class B**] speaker output circuits.

6. Other Available Features Required by Project:

   a. Minimum of [**four**][**eight**]<**Insert number**>[**Class A**][**Class B**] synchronized strobe power circuits.
   b. [**Four**][**Eight**]<**Insert number**> digitally pre-recorded voice messages.
   c. Push-to-Talk (PTT) microphone.

2.9 FIRE-ALARM TERMINAL CABINETS

A. Description: A cabinet with hinged, lockable cover clearly labeled and intended for termination of fire-alarm conductors at junction points. Screw-type terminal blocks are provided within the terminal cabinet for conductor splices.

B. UL UOXX - Fire-Alarm Terminal Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Space Age Electronics, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Space Age Electronics, Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. System Control Unit Accessories: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Labeled "FIRE ALARM TERMINAL CABINET."
b. Interior field identification labels.
c. Sized accordingly to contain required number of termination points.
d. Accessible by authorized personnel only.

2.10 MANUAL FIRE-ALARM BOXES

A. Description: A manually operated device used to initiate a fire-alarm signal. Manual fire-alarm boxes come in both conventional or addressable models and may require a single-action (pull down) or double-action (push in and pull down) to initiate a fire-alarm signal. These initiating devices are sometimes referred to as manual fire-alarm stations, pull stations, or call points.

B. UL UNIU - Single-Action Manual Fire-Alarm Boxes :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Firecom, Inc.**]
d. [**Gamewell-FCI; Honeywell International, Inc.**]
e. [**Kidde; Carrier Global Corporation**]
f. [**Kingfisher Company, Inc.**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Potter Electric Signal Company, LLC**]
i. [**Safety Technology International, Inc.**]
j. [**Security Door Controls**]
k. [**Siemens Industry, Inc.; Fire Safety Division**]
l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]

m. [**System Sensor; Honeywell International, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Firecom, Inc.**]
d. [**Gamewell-FCI; Honeywell International, Inc.**]
e. [**Kidde; Carrier Global Corporation**]
f. [**Kingfisher Company, Inc.**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Potter Electric Signal Company, LLC**]
i. [**Safety Technology International, Inc.**]
j. [**Security Door Controls**]
k. [**Siemens Industry, Inc.; Fire Safety Division**]
l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
m. [**System Sensor; Honeywell International, Inc.**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Non-Coded Fire-Alarm Boxes: UL CCN UNIU, including UL 38 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Colored red with raised letters providing operating instructions.
c. [**Surface**][**Recessed**]<**Insert mounting arrangement**> mounted.
d. Station Reset: [**Key**][**Wrench**] operated switch.
e. Material: [**Polycarbonate**][**Metal**].

C. UL UNIU - Double-Action Manual Fire-Alarm Boxes :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Firecom, Inc.**]
d. [**Gamewell-FCI; Honeywell International, Inc.**]
e. [**Kidde; Carrier Global Corporation**]
f. [**Kingfisher Company, Inc.**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Potter Electric Signal Company, LLC**]
i. [**Safety Technology International, Inc.**]

j. [**Security Door Controls**]
k. [**Siemens Industry, Inc.; Fire Safety Division**]
l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
m. [**System Sensor; Honeywell International, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Firecom, Inc.**]
d. [**Gamewell-FCI; Honeywell International, Inc.**]
e. [**Kidde; Carrier Global Corporation**]
f. [**Kingfisher Company, Inc.**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Potter Electric Signal Company, LLC**]
i. [**Safety Technology International, Inc.**]
j. [**Security Door Controls**]
k. [**Siemens Industry, Inc.; Fire Safety Division**]
l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
m. [**System Sensor; Honeywell International, Inc.**]
n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Non-Coded Fire-Alarm Boxes: UL CCN UNIU, including UL 38 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Chs. 10 and 17 of NFPA 72.
b. Colored red with raised letters providing operating instructions.
c. [**Surface**][**Recessed**]<**Insert mounting arrangement**> mounted.
d. Station Reset: [**Key**][**Wrench**] operated switch.
e. Material: [**Polycarbonate**][**Metal**].

D. Accessories:

1. Factory-fabricated clear plastic enclosure[**with battery-operated sounder**].
2. Weatherproof protective shield for conventional manual fire-alarm boxes located outdoors.

2.11 HEAT-SENSING FIRE DETECTORS

A. Description: A fire detector that detects either abnormally high temperatures or rate-of-temperature rise, or both.

B. UL UQGS - Fixed-Temperature Heat Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Edwards; Carrier Global Corporation**]
    b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
    c. [**Gamewell-FCI; Honeywell International, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Kidde; Carrier Global Corporation**]
    g. [**Notifier; Honeywell International, Inc.**]
    h. [**Siemens Industry, Inc.; Fire Safety Division**]
    i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Edwards; Carrier Global Corporation**]
    b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
    c. [**Gamewell-FCI; Honeywell International, Inc.**]
    d. [**Honeywell International Inc.**]
    e. [**Johnson Controls, Inc.**]
    f. [**Kidde; Carrier Global Corporation**]
    g. [**Notifier; Honeywell International, Inc.**]
    h. [**Siemens Industry, Inc.; Fire Safety Division**]
    i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Heat-Detecting-Type Automatic Fire Detectors: UL CCN UQGS, including UL 521 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Actuated by temperature that exceeds fixed temperature of [**135 deg F (57 deg C)**][**155 deg F (68 deg C)**][**190 deg F (88 deg C)**][**220 deg F (104 deg C)**] regardless of rate of temperature rise.
    c. [**Conventional**][**Addressable**]-type initiating device.
    d. Detector must have functional humidity range of 10 to 90 percent.

C. UL UQGS - Rate-Compensated Heat Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Edwards; Carrier Global Corporation**]
    b. [**Gamewell-FCI; Honeywell International, Inc.**]
    c. [**Honeywell International Inc.**]

d. [**Johnson Controls, Inc.**]
e. [**Notifier; Honeywell International, Inc.**]
f. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Edwards; Carrier Global Corporation**]
b. [**Gamewell-FCI; Honeywell International, Inc.**]
c. [**Honeywell International Inc.**]
d. [**Johnson Controls, Inc.**]
e. [**Notifier; Honeywell International, Inc.**]
f. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Heat-Detecting-Type Automatic Fire Detectors: UL CCN UQGS, including UL 521 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Outer metal construction and inner metal components, which eliminate nuisance alarms due to thermal lag.
c. Actuated by temperature that exceeds fixed temperature of [**135 deg F (57 deg C)**][**155 deg F (68 deg C)**][**190 deg F (88 deg C)**][**220 deg F (104 deg C)**] regardless of rate of temperature rise.

D. UL UQGS - Spot-Type Heat Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Heat-Detecting-Type Automatic Fire Detectors: UL CCN UQGS, including UL 521 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Field programmable.
c. Resettable from the control unit.
d. Removable from the base assembly without the use of tools and without disturbing the wiring connections.
e. Actuated by temperature that exceeds fixed temperature of [**135 deg F (57 deg C)**][**155 deg F (68 deg C)**][**190 deg F (88 deg C)**][**220 deg F (104 deg C)**] regardless of rate of temperature rise.
f. [**Conventional**][**Addressable**]-type initiating device.
g. Detector must have functional humidity range of 10 to 90 percent.

E. UL UQGS - Line-Type Heat Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**The Protectowire Co., Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**The Protectowire Co., Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Heat-Detecting-Type Automatic Fire Detectors: UL CCN UQGS, including UL 521 and

NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Cable Type: [**Standard digital heat-sensitive cable**][**Confirmed temperature initiation cable**][**Fiber-optic cable with low-smoke zero-halogen jacket**].
c. Actuated by temperature that exceeds fixed temperature of [**135 deg F (57 deg C)**][**155 deg F (68 deg C)**][**190 deg F (88 deg C)**][**220 deg F (104 deg C)**] regardless of rate of temperature rise.
d. [**Conventional**][**Programmable**]-type initiating device supervised by [**addressable input module**][**intelligent sub-panel**].

F. Accessories:

1. Heat detector protective guard.

2.12 SMOKE-SENSING FIRE DETECTORS

A. Description: A device that detects visible or invisible particles of combustion and initiates an action. Types of smoke-sensing fire detectors include spot-type detectors, air-sampling detectors, projected beam-type detectors, duct detectors, multi-criteria detectors, and video image smoke detectors.

B. UL UROX - Spot-Type Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Field programmable.
    c. Resettable from the control unit.
    d. Removable from the base assembly without the use of tools and without disturbing the wiring connections.
    e. Sensing Type: [**Photoelectric**][**Ionization**].

C. UL UROX - Air Sampling-Type Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Gamewell-FCI; Honeywell International, Inc.**]
    b. [**Honeywell International Inc.**]
    c. [**Notifier; Honeywell International, Inc.**]
    d. [**Siemens Industry, Inc.; Fire Safety Division**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Gamewell-FCI; Honeywell International, Inc.**]
    b. [**Honeywell International Inc.**]
    c. [**Notifier; Honeywell International, Inc.**]
    d. [**Siemens Industry, Inc.; Fire Safety Division**]
    e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Piping system and fan to transport particles of combustion to detector chamber.
    c. Detectors must communicate with FACU via addressable smoke detector installed in housing[**, monitored dry contact closures**][**, and interface modules**].
    d. Pipe length and hole sizes must be in accordance with manufacturer's published instructions[**and airflow balancing calculations performed using approved calculation software**].
    e. Detector and Aspirator: Housed in mounting box and arranged such that air is drawn from

detection area and sample passes through detector chamber.
f. Detector must transmit faults to the FACU.

6. Other Available Features Required by Project:

a. <**Insert available feature**>.

D. UL UROX - Projected Beam-Type Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Fire-Lite Alarms; Honeywell International, Inc.**]
b. [**Honeywell International Inc.**]
c. [**Notifier; Honeywell International, Inc.**]
d. [**Siemens Industry, Inc.; Fire Safety Division**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Fire-Lite Alarms; Honeywell International, Inc.**]
b. [**Honeywell International Inc.**]
c. [**Notifier; Honeywell International, Inc.**]
d. [**Siemens Industry, Inc.; Fire Safety Division**]
e. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Detector Address: Accessible from FACU and able to identify detector's location within system and its sensitivity setting.
c. Operator at FACU, having designated access level, must be able to manually access the following for each detector: primary status, device type, present average value, present sensitivity selected, and sensor range.

E. UL UROX - Duct Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]

c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Edwards; Carrier Global Corporation**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Kidde; Carrier Global Corporation**]
g. [**Notifier; Honeywell International, Inc.**]
h. [**Siemens Industry, Inc.; Fire Safety Division**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
d. Integral Visual-Indicating Light: LED type, indicating detector has operated.
e. Detectors must be four- or two-wire type.
f. Detector address must be accessible from fire-alarm control unit and must be able to identify the detector's location within the system and its sensitivity setting.
g. Operator at FACU, having designated access level, must be able to manually access the following for each detector: primary status, device type, present average value, present sensitivity selected, and sensor range.

F. UL UROX - Video Image Smoke Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**SigniFire, Fike Corp.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the

following:

a. [**SigniFire, Fike Corp.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Unit dedicated to task of video fire detection should not be running any additional software, as it can compromise its detection.
   c. Camera viewing must use graphic user interface with independent video codecs to provide continuous analysis of video images.
   d. Smoke must be detected by monitoring of small areas of change within image and passing these pixel changes to processor for analysis.
   e. Unit must employ algorithms to process video information from up to four cameras simultaneously.
   f. Unit must achieve 25 Hz frame rate for each of four channels.
   g. Outputs: Minimum of 16 alarm outputs that may be individually assigned to combination of zones or sectors. These outputs must not be linked to any particular camera, allowing for zonal and image association.
   h. Through output logic matrix, operator must have ability to customize systems output to alarm conditions and, therefore, allow easy integration within "house" fire-alarm system.

2.13 RADIANT ENERGY-SENSING FIRE DETECTORS

A. Description: A device that detects radiant energy, such as ultraviolet, visible, or infrared, that is emitted as a product of combustion reaction and obeys the laws of optics. Common types of radiant energy-sensing fire detectors include video image flame detectors.

B. UL UIAZ - Video Image Flame Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fike Corporation**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Fike Corporation**]
   b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.

4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Automatic Fire Detectors for Use in Hazardous Locations: UL CCN UIAZ, including UL 268 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Unit dedicated to task of video fire detection should not be running any additional software, as it can compromise its detection.
    c. Camera viewing must use graphic user interface with independent video codecs to provide continuous analysis of video images.
    d. Unit must employ algorithms to process video information from up to four cameras simultaneously.
    e. Unit must achieve 25 Hz frame rate for each of four channels.
    f. Outputs: Minimum of 16 alarm outputs that may be individually assigned to combination of zones or sectors. These outputs must not be linked to any particular camera, allowing for zonal and image association.
    g. Through output logic matrix, operator must have ability to customize systems output to alarm conditions and, therefore, allow easy integration within "house" fire-alarm system.

2.14 COMBINATION, MULTI-CRITERIA, AND MULTI-SENSOR DETECTORS

A. Description: A device that contains multiple sensors that separately respond to physical stimulus such as heat, smoke, or fire gases, or employs more than one sensor to sense the same stimulus. This sensor is capable of generating only one alarm signal from the sensor employed in the design either independently or in combination. The sensor output signal is mathematically evaluated to determine when an alarm signal is warranted. The evaluation can be performed either at the detector or at the control unit. This detector can have a single listing that establishes the primary function of the detector, or can have listings for each sensing method employed.

B. UL UROX - Multi-Criteria Detector :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Detectors Designed for Smoke Particles: UL CCN UROX, including UL 268 and NFPA 72.

4. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Field programmable.
    c. Resettable from the control unit.
    d. Removable from the base assembly without the use of tools and without disturbing the

wiring connections.
e. Smoke Sensing Type: [**Photoelectric**][**Ionization**].
f. Heat Sensing Type: Fixed temperature[**and combination rate-of-rise**].

2.15 CARBON MONOXIDE DETECTORS

A. Description: A device that detects the presence of a specific carbon monoxide concentration.

B. UL FTAM - Carbon Monoxide Detectors :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Digital Monitoring Products**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Notifier; Honeywell International, Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Digital Monitoring Products**]
b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
c. [**Gamewell-FCI; Honeywell International, Inc.**]
d. [**Honeywell International Inc.**]
e. [**Johnson Controls, Inc.**]
f. [**Notifier; Honeywell International, Inc.**]
g. [**Potter Electric Signal Company, LLC**]
h. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
i. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Detectors and Sensors Designed to Detect Gases and Vapors: UL CCN FTAM, including UL 2075 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Detector sends trouble alarm when nearing end of life or experiencing power supply problems or internal faults.

c. Detector sounder base emits Temporal-4 signal.
d. Testable by introducing test carbon monoxide into sensing cell.

2.16 SPRINKLER WATERFLOW ALARM-INITIATING DEVICES

A. Description: An initiating device used to monitor the flow of water in a wet-pipe or dry-pipe sprinkler system for the purpose of initiating an alarm signal. These devices employ operating mechanisms that include paddle operation, pressure operation, or mechanical operation.

B. UL USQT - Sprinkler Waterflow Alarm-Initiating Device :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Activation of the initiating device occurs within 90 seconds of waterflow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system.
   c. Movement of water due to waste, surges, or variable pressure must not initiate an alarm signal.
   d. Adjustable time delay.
   e. Pressure Range: **20 to 175 psig (1.38 to 12.07 bar)**.
   f. Operating Type: [**Paddle**][**Pressure**][**Mechanically**] operated.
   g. [**Coded**][**Non-coded**] signaling contacts.

2.17 AUDIBLE NOTIFICATION APPLIANCES

A. Description: A fire-alarm system component such as a horn or loudspeaker that provides audible output to alert occupants by the sense of hearing.

B. UL ULSZ - Horns :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
   b. [**Cerberus; Siemens Industry, Inc.**]
   c. [**Cooper Wheelock; brand of Eaton**]

d. [**Edwards; Carrier Global Corporation**]
e. [**Kidde Commercial Fire & Life Safety Systems**]
f. [**Siemens Industry, Inc.; Fire Safety Division**]
g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ansul; brand of Johnson Controls International plc, Building Solutions North America**]
b. [**Cerberus; Siemens Industry, Inc.**]
c. [**Cooper Wheelock; brand of Eaton**]
d. [**Edwards; Carrier Global Corporation**]
e. [**Kidde Commercial Fire & Life Safety Systems**]
f. [**Siemens Industry, Inc.; Fire Safety Division**]
g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
h. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Electrically Operated Signal-Sounding Appliances: UL CCN ULSZ, including UL 464 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 18 of NFPA 72.
b. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
c. Field-selectable volume settings.
d. Compatible with wires up to 12 AWG.
e. Capable of projecting through high ambient sound levels.
f. Designed to provide accurate reproduction of audible emergency and protective signals.
g. Flexibility of mounting on vertical or horizontal positions.

C. UL UUMW - Loudspeakers :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Atlas Sound LP**]
b. [**Edwards; Carrier Global Corporation**]
c. [**Federal Signal Corporation**]
d. [**Johnson Controls, Inc.**]
e. [**Kidde Commercial Fire & Life Safety Systems**]
f. [**Potter Electric Signal Company, LLC**]
g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Atlas Sound LP**]
    b. [**Edwards; Carrier Global Corporation**]
    c. [**Federal Signal Corporation**]
    d. [**Johnson Controls, Inc.**]
    e. [**Kidde Commercial Fire & Life Safety Systems**]
    f. [**Potter Electric Signal Company, LLC**]
    g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Speakers and Amplifiers Used in Fire-Alarm and/or Emergency Communication Systems: UL CCN UUMW, including UL 1480 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 18 of NFPA 72.
    b. Flush and ceiling-tile mounting with use of ceiling tile brackets.
    c. Field-selectable voltage and power tap settings.
    d. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
    e. Compatible with wires up to 12 AWG.

D. Accessories:

1. Audible appliance protective guard.

2.18 VISUAL NOTIFICATION APPLIANCES

A. Description: A fire-alarm system component that provides a visible output to alert occupants by the sense of sight, including visual strobes.[**Textual visual notification appliances are specified in Section 284700 "Mass Notification."**]

B. UL UVAV - Strobe :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Avenger Systems LLC**]
    b. [**Cooper Wheelock; brand of Eaton**]
    c. [**Edwards; Carrier Global Corporation**]
    d. [**Gentex Corporation**]
    e. [**Kidde Commercial Fire & Life Safety Systems**]
    f. [**Potter Electric Signal Company, LLC**]
    g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
    h. [**Triga Life Safety Systems LLC**]
    i. [**VES Fire Detection Systems; Hochiki America Corporation**]

j. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Avenger Systems LLC**]
b. [**Cooper Wheelock; brand of Eaton**]
c. [**Edwards; Carrier Global Corporation**]
d. [**Gentex Corporation**]
e. [**Kidde Commercial Fire & Life Safety Systems**]
f. [**Potter Electric Signal Company, LLC**]
g. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
h. [**Triga Life Safety Systems LLC**]
i. [**VES Fire Detection Systems; Hochiki America Corporation**]
j. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Visual-Signal Appliances for Fire-Protective Signaling Applications: UL CCN UVAV, including UL 1638 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 18 of NFPA 72.
b. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
c. Compatible with wires up to 12 AWG.
d. Rated Light Output:[**6,**][**13,**] 15, 30, 75,[**or**] 110[**, or 177**] candela.
e. Field-selectable candela settings.
f. Clear or nominal white polycarbonate lens mounted on faceplate.

6. Other Available Features Required by Project:

a. For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
b. Weather resistant to provide protection against water, humidity, and corrosion.

C. Accessories:

1. Visual appliance protective guard.

2.19 COMBINATION AUDIBLE/VISUAL NOTIFICATION APPLIANCES

A. Description: A fire-alarm system component such as a horn/strobe or loudspeaker/strobe that provides both an audible and a visible output to alert occupants by the sense of hearing and sight.

B. UL ULSZ and UVAV - Combination Horn/Strobe Appliances :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Cooper Wheelock; brand of Eaton**]
b. [**Gentex Corporation**]
c. [**Hochiki America Corporation**]
d. [**Potter Electric Signal Company, LLC**]
e. [**VES Fire Detection Systems; Hochiki America Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cooper Wheelock; brand of Eaton**]
b. [**Gentex Corporation**]
c. [**Hochiki America Corporation**]
d. [**Potter Electric Signal Company, LLC**]
e. [**VES Fire Detection Systems; Hochiki America Corporation**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Electrically Operated Signal-Sounding Appliances or Visual-Signal Appliances for Fire-Protective Signaling Applications: UL CCN ULSZ and UVAV, including UL 464, UL 1638, and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 18 of NFPA 72.
b. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
c. Compatible with wires up to 12 AWG.
d. Rated Light Output:[**6,**][**13,**] 15, 30, 75,[**or**] 110[**, or 177**] candela.
e. Clear or nominal white polycarbonate lens mounted on faceplate.
f. Strobe flash rate of 1 Hz over its entire operating range.
g. Operates on a coded or non-coded power supply.
h. Field-selectable candela settings.
i. Field-selectable volume settings.
j. Universal mounting plate for ceiling units.

6. Other Available Features Required by Project:

a. For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
b. Weather resistant to provide protection against water, humidity, and corrosion.

C. UL UUMW and UVAV - Combination Loudspeaker/Strobe Appliances :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Cooper Wheelock; brand of Eaton**]
b. [**Gentex Corporation**]
c. [**Hochiki America Corporation**]
d. [**Potter Electric Signal Company, LLC**]
e. [**VES Fire Detection Systems; Hochiki America Corporation**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Cooper Wheelock; brand of Eaton**]
b. [**Gentex Corporation**]
c. [**Hochiki America Corporation**]
d. [**Potter Electric Signal Company, LLC**]
e. [**VES Fire Detection Systems; Hochiki America Corporation**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Electrically Operated Signal-Sounding Appliances or Visual-Signal Appliances for Fire-Protective Signaling Applications: UL CCN UUMW and UVAV, including UL 1480, UL 1638, and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 18 of NFPA 72.
b. Operating Temperature Range: **32 deg F to 120 deg F (0 deg C to 50 deg C)**.
c. Compatible with wires up to 12 AWG.
d. Rated Light Output:[**6,**][**13,**] 15, 30, 75,[**or**] 110[**, or 177**] candela.
e. Clear or nominal white polycarbonate lens mounted on faceplate.
f. Strobe flash rate of 1 Hz over its entire operating range.
g. Field-selectable candela settings.
h. Field-selectable voltage and power settings.
i. Universal mounting plate for ceiling units.

6. Other Available Features Required by Project:

a. For units with guards to prevent physical damage, light output ratings must be determined with guards in place.

7. Accessories:

a. Combination audible/visual appliance protective guard.
b. Weather resistant to provide protection against water, humidity, and corrosion.

2.20 FIREFIGHTERS' TWO-WAY, IN-BUILDING WIRED TELEPHONE COMMUNICATIONS SYSTEM

A. Description: A two-way in-building telephone communications system used by firefighters and emergency response personnel when responding to, investigating, and conducting rescue activities in a fire incident.

B. Firefighters' Two-Way, In-Building Wired Telephone Communications System :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fike Corporation**]
   b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   c. [**Firecom, Inc.**]
   d. [**Gamewell-FCI; Honeywell International, Inc.**]
   e. [**Keltron Corporation**]
   f. [**Kidde; Carrier Global Corporation**]
   g. [**Kingfisher Company, Inc.**]
   h. [**Notifier; Honeywell International, Inc.**]
   i. [**Potter Electric Signal Company, LLC**]
   j. [**Siemens Industry, Inc.; Fire Safety Division**]
   k. [**Silent Knight; Honeywell International, Inc.**]
   l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   m. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
   n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Fike Corporation**]
   b. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   c. [**Firecom, Inc.**]
   d. [**Gamewell-FCI; Honeywell International, Inc.**]
   e. [**Keltron Corporation**]
   f. [**Kidde; Carrier Global Corporation**]
   g. [**Kingfisher Company, Inc.**]
   h. [**Notifier; Honeywell International, Inc.**]
   i. [**Potter Electric Signal Company, LLC**]
   j. [**Siemens Industry, Inc.; Fire Safety Division**]
   k. [**Silent Knight; Honeywell International, Inc.**]
   l. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
   m. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
   n. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one or more of the following UL product categories:

   a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.
   b. Control Units, System: UL CCN UOJZ, including UL 864 and NFPA 72.
   c. Control Units, Releasing Device: UL CCN SYZV, including UL 864 and NFPA 72, in addition to standards related to suppressant or energy storage system being released.
   d. Control and Communications Equipment: UL CCN PGWM, including UL 2572 and NFPA 72.
   e. Smoke Control System Equipment: UL CCN UUKL, including UL 864, NFPA 72, and NFPA

92.

5. Standard Features:

   a. Product Reference Standards: Ch. 24 of NFPA 72.
   b. <**Insert existing system features that must be maintained**>.

2.21 FIRE-ALARM SUPERVISED CONTROL MODULE INTERFACES FOR FIRE SAFETY FUNCTIONS

A. Description: An addressable fire-alarm control module that interfaces to another building system for the purpose of initiating an action for that system based upon activation of a supervisory or alarm condition on the fire-alarm system. The interface between the control module and the other building system or equipment is supervised.

B. UL UOXX - Fire-Alarm Supervised Control Module :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   b. [**Firecom, Inc.**]
   c. [**Gamewell-FCI; Honeywell International, Inc.**]
   d. [**Johnson Controls, Inc.**]
   e. [**Notifier; Honeywell International, Inc.**]
   f. [**Siemens Industry, Inc.; Fire Safety Division**]
   g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   b. [**Firecom, Inc.**]
   c. [**Gamewell-FCI; Honeywell International, Inc.**]
   d. [**Johnson Controls, Inc.**]
   e. [**Notifier; Honeywell International, Inc.**]
   f. [**Siemens Industry, Inc.; Fire Safety Division**]
   g. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Control Unit Accessories - Addressable Control Modules: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Field programmable.
   c. Resettable from the control unit.

d. Supervises [**Class A**][**and**][**Class B**] initiating device circuits.
e. Capable of interfacing with the following systems:

1) Elevator controller.
2) Elevator power shunt-trip.
3) Elevator shunt-trip power monitoring.
4) HVAC line voltage.
5) Building management system.
6) Magnetic door hold-open circuits.
7) High-volume low-speed fans.
8) [**Door**][**Shutter**] release.
9) Electrically locked doors.
10) <**Insert interface type**>.

2.22 FIRE-ALARM SUPERVISORY SIGNAL-INITIATING DEVICES

A. Description: An initiating device such as a valve supervisory switch, water-level indicator, low-air-pressure switch, or low-temperature switch in which the change of state signals to the [**fire-alarm**][**releasing device**] control unit an off-normal condition and its restoration to normal of a fire-protection or life-safety system; or a need for action in connection with guard tours, fire-suppression systems or equipment, or maintenance features of related systems.

B. UL USQT - Control Valve Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Kopler, LLC**]
b. [**Lansdale Valve and Manufacturing**]
c. [**Potter Electric Signal Company, LLC**]
d. [**Southern Valve & Fitting USA**]
e. [**Tyco Fire and Building Products; brand of Johnson Controls International plc, Building Solutions North America**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Kopler, LLC**]
b. [**Lansdale Valve and Manufacturing**]
c. [**Potter Electric Signal Company, LLC**]
d. [**Southern Valve & Fitting USA**]
e. [**Tyco Fire and Building Products; brand of Johnson Controls International plc, Building Solutions North America**]
f. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Initiation of two separate and distinct signals; one indicating movement of the valve from its normal position, and the other indicating restoration of the valve to its normal position.
    c. Off-normal signal must be initiated during the first two revolutions of the handwheel, or during one-fifth of the travel distance of the valve from its normal position.
    d. Off-normal signal must not be restored at any valve position except normal.

C. UL USQT - Pressure-Monitoring/Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Potter Electric Signal Company, LLC**]
    b. [**Viking Group Inc.**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Potter Electric Signal Company, LLC**]
    b. [**Viking Group Inc.**]
    c. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Extinguishing System Attachments: UL CCN USQT, including UL 346, and NFPA 72.

5. Standard Features:

    a. Product Reference Standards: Ch. 17 of NFPA 72.
    b. Initiation of two separate and distinct signals; one indicating that the required pressure has increased or decreased (off-normal), and the other indicating restoration of the pressure to its normal value.

D. UL USQT - Water Level Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Potter Electric Signal Company, LLC**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Potter Electric Signal Company, LLC**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Initiation of two separate and distinct signals; one indicating that the required water level has been lowered or raised (off-normal), and the other indicating restoration of the water level to normal.
   c. Initiates a low-water-level signal when the water level falls **12 inch (300 mm)** in other than pressure tanks.
   d. Pressure Tank: Off-normal signal initiated when the water level falls **3 inch (76 mm)** or rises **3 inch (76 mm)**.

E. UL USQT - Water Temperature Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Initiates two separate and distinct signals; one indicating a decrease in water temperature to **40 deg F (4.5 deg C)**, and the other indicating its restoration to above **40 deg F (4.5 deg C)**.

F. UL USQT - Room Temperature Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product

categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Initiates two separate and distinct signals; one indicating a decrease in room temperature to **40 deg F (4.5 deg C)**, and the other indicating its restoration to above **40 deg F (4.5 deg C)**.

G. UL USQT - Fire Extinguisher Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Indicates conditions for a specific fire extinguisher to a fire-alarm control unit.

H. UL USQT - Fire Pump Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Extinguishing System Attachments: UL CCN USQT, including UL 346 and NFPA 72.

4. Standard Features:

a. Product Reference Standards: Ch. 17 of NFPA 72.
b. Initiates a supervisory signal for any off-normal conditions of a fire pump, including the following:

1) Fire pump running.
2) Fire pump loss of power.
3) Fire pump phase reversal.
4) Fire pump transfer to secondary power.

I. UL UOXX - Generator Supervisory Signal-Initiating Devices :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. System Control Unit Accessories: UL CCN UOXX, including UL 864 and NFPA 72.

4. Standard Features:

   a. Product Reference Standards: Ch. 17 of NFPA 72.
   b. Initiates a supervisory signal upon indication of generator running condition.

2.23 FIRE-ALARM DIGITAL ALARM COMMUNICATOR TRANSMITTERS

A. Description: A fire-alarm system component at the protected premises to which the fire-alarm control unit connects and transmit signals indicating a status change of initiating devices or groups of devices. The DACT seizes the connected [**telephone line**][**cellular signal**][**ethernet network**], dials a preselected number to connect to a DACR, and transmits signals indicating a status change of the initiating devices.

B. UL UOXX - Fire-Alarm Digital Alarm Communicator Transmitter :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Ademco; Honeywell**]
   b. [**Digital Monitoring Products**]
   c. [**Fike Corporation**]
   d. [**Fire-Lite Alarms; Honeywell International, Inc.**]
   e. [**Firecom, Inc.**]
   f. [**Gamewell-FCI; Honeywell International, Inc.**]
   g. [**Keltron Corporation**]
   h. [**Kidde; Carrier Global Corporation**]
   i. [**Kingfisher Company, Inc.**]
   j. [**Notifier; Honeywell International, Inc.**]
   k. [**Potter Electric Signal Company, LLC**]
   l. [**Siemens Industry, Inc.; Fire Safety Division**]
   m. [**Silent Knight; Honeywell International, Inc.**]
   n. [**Simplex; brand of Johnson Controls International plc, Building Solutions North**

America]
o. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
p. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Ademco; Honeywell**]
b. [**Digital Monitoring Products**]
c. [**Fike Corporation**]
d. [**Fire-Lite Alarms; Honeywell International, Inc.**]
e. [**Firecom, Inc.**]
f. [**Gamewell-FCI; Honeywell International, Inc.**]
g. [**Keltron Corporation**]
h. [**Kidde; Carrier Global Corporation**]
i. [**Kingfisher Company, Inc.**]
j. [**Notifier; Honeywell International, Inc.**]
k. [**Potter Electric Signal Company, LLC**]
l. [**Siemens Industry, Inc.; Fire Safety Division**]
m. [**Silent Knight; Honeywell International, Inc.**]
n. [**Simplex; brand of Johnson Controls International plc, Building Solutions North America**]
o. [**Tyco Security Products and Solutions; brand of Johnson Controls**]
p. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Product Reference Standards: Ch. 26 of NFPA 72.
b. Compatible with [**remote alarm receiving station**][**central station**] receiver.
c. Receive alarm, supervisory, or trouble signals from FACU and automatically transmit to [**remote alarm receiving station**][**central station**] via [**telephone line(s)**][**cellular network**][**internet**]<**Insert method**>.
d. Indicate trouble signal at FACU upon loss of communication with the [**remote alarm receiving station**][**central station**].
e. Indicate local trouble signal upon loss of communication with the FACU.
f. Secondary Power: Integral rechargeable battery and automatic charger.
g. Digital data transmission of the following signals:

1) Address of alarm-initiating device.
2) Address of supervisory signal.
3) Address of trouble-initiating device.
4) Loss of AC supply.
5) Loss of power.
6) Low battery.
7) Abnormal test signal.
8) Communication bus failure.

9) <**Insert signal to be transmitted**>.

h. Self-test automatically performed every 24 hours with report transmitted to [**remote alarm receiving station**][**central station**].

2.24 FIRE-ALARM RADIO ALARM TRANSMITTERS

A. Description: A fire-alarm system component at the protected premises to which the fire-alarm control unit connects and transmit signals indicating a status change of initiating devices or groups of devices. The RAT transmits signals through a dedicated, licensed radio channel to the radio alarm receiver.

B. UL UOXX - Fire-Alarm Radio Alarm Transmitter :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**AES Corporation (The)**]
   b. [**Keltron Corporation**]
   c. [**Kingfisher Company, Inc.**]
   d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**AES Corporation (The)**]
   b. [**Keltron Corporation**]
   c. [**Kingfisher Company, Inc.**]
   d. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Control Unit Accessories for Fire-Protective Signaling Systems: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

   a. Product Reference Standards: Ch. 26 of NFPA 72.
   b. Modular UL 50E, Type 1 metal enclosure with tamper-resistant flush tumbler lock.
   c. Compatible and coordinated with operating characteristics of remote-alarm receiving-station receiver.
   d. Receive alarm, supervisory, or trouble signals from FACU and automatically transmit to remote alarm receiving station via [**VHF**][**UHF**]<**Insert frequency**> radio frequency using 2 W power output.
   e. Indicate trouble signal at FACU upon loss of communication with the remote alarm receiving station.
   f. Indicate local trouble signal upon loss of communication with the FACU.
   g. Normal Power Input: 120 V(ac).
   h. Secondary Power: Integral sealed, rechargeable, 12 V battery and charger.
   i. Omnidirectional, coaxial half-wave, dipole-type antenna with driving point impedance

matched to transmitter and antenna cable output impedance.

j. Dry-contact inputs[**and serial communications interface**] to receive connections from fire-alarm system circuit boards, modules, and other auxiliary devices

k. Digital data transmission of the following signals:

1) [**Address**][**Zone**] of alarm-initiating device.
2) [**Address**][**Zone**] of supervisory signal.
3) [**Address**][**Zone**] of trouble-initiating device.
4) Loss of AC supply.
5) Loss of power.
6) Low battery.
7) Abnormal test signal.
8) Communication bus failure.
9) <**Insert signal to be transmitted**>.

l. Self-test automatically performed every 24 hours with report transmitted to [**remote alarm receiving station**][**central station**].

2.25 FIRE-ALARM RECORD DOCUMENTATION CABINETS

A. Description: A cabinet clearly labeled and intended for the storage of fire-alarm record documents, including as-built drawings; programming documentation; and inspection, testing, and maintenance documentation.

B. UL UOXX - Fire-Alarm-System Record-Documents Storage Cabinet :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Space Age Electronics, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Space Age Electronics, Inc.**]
b. <**Insert manufacturer's name**>

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. System Control Unit Accessories: UL CCN UOXX, including UL 864 and NFPA 72.

5. Standard Features:

a. Labeled "SYSTEM RECORD DOCUMENTS."
b. Sized accordingly to contain all necessary documentation.
c. Accessible by authorized personnel only.

2.26 PASSIVE GRAPHIC MAPS

A. Description: A printed graphic map showing building floor plans indicating initiating device locations and control equipment locations for use by emergency responders and maintenance personnel.

B. Fire-Alarm Passive Graphic Map :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Source Limitations: Obtain products from single manufacturer.
3. Standard Features:

a. Product Reference Standards: Ch. 7 of NFPA 72.
b. Indicates initiating device type, locations, and corresponding addresses.
c. Indicates control equipment locations.
d. Mounted in a plexiglass frame adjacent to the FACU.
e. Legible and sized accordingly.

2.27 FIRE-ALARM CABLES

A. UL HNHT - Non-Power-Limited Fire-Alarm Circuit Cable (NPLF) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Comtran Corporation**]
b. [**Genesis; Resideo Technologies, Inc.**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Radix Wire**]
e. [**Remee Wire & Cable; Remee Products Corporation**]
f. [**Southwire Company, LLC**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. [**West Penn Wire; brand of Belden, Inc.**]
i. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Comtran Corporation**]
b. [**Genesis; Resideo Technologies, Inc.**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Radix Wire**]
e. [**Remee Wire & Cable; Remee Products Corporation**]
f. [**Southwire Company, LLC**]
g. [**Superior Essex Inc.; subsidiary of LS Corp.**]
h. [**West Penn Wire; brand of Belden, Inc.**]
i. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Non-Power-Limited Fire-Alarm Cable: UL CCN HNHT; including UL 1425 and Article 760 of NFPA 70.
    b. Vertical-Tray Flame Test: UL 1685.
    c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.

4. Standard Features:

    a. [**Solid**][**Stranded**] copper conductors with 600 V rated, 75 deg C, color-coded insulation.
    b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

B. UL HNHT - Non-Power-Limited Fire-Alarm Circuit Plenum Cable (NPLFP) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Prysmian Cables and Systems; Prysmian Group North America**]
    b. [**Southwire Company, LLC**]
    c. [**West Penn Wire; brand of Belden, Inc.**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Prysmian Cables and Systems; Prysmian Group North America**]
    b. [**Southwire Company, LLC**]
    c. [**West Penn Wire; brand of Belden, Inc.**]
    d. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Non-Power-Limited Fire-Alarm Cable: UL CCN HNHT; including UL 1425 and Article 760 of NFPA 70.
    b. Vertical-Tray Flame Test: UL 1685.
    c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.
    d. Plenum Rating: NFPA 262[**and New York City Electrical Code**].

4. Standard Features:

    a. [**Solid**][**Stranded**] copper conductors with 600 V rated, 75 deg C, color-coded insulation.
    b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

C. UL HNHT - Non-Power-Limited Fire-Alarm Circuit Riser Cable (NPLFR) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Comtran Corporation**]
    b. [**Prysmian Cables and Systems; Prysmian Group North America**]

c. [**Radix Wire**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Comtran Corporation**]
b. [**Prysmian Cables and Systems; Prysmian Group North America**]
c. [**Radix Wire**]
d. [**Southwire Company, LLC**]
e. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Non-Power-Limited Fire-Alarm Cable: UL CCN HNHT; including UL 1425 and Article 760 of NFPA 70.
b. Vertical-Tray Flame Test: UL 1685.
c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.
d. Riser Rating: UL 1666.

4. Standard Features:

a. [**Solid**][**Stranded**] copper conductors with 600 V rated, 75 deg C, color-coded insulation.
b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

D. UL HNIR - Power-Limited Fire-Alarm Cable (FPL) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Comtran Corporation**]
b. [**Genesis; Resideo Technologies, Inc.**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Radix Wire**]
e. [**Remee Wire & Cable; Remee Products Corporation**]
f. [**Southwire Company, LLC**]
g. [**West Penn Wire; brand of Belden, Inc.**]
h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Comtran Corporation**]
b. [**Genesis; Resideo Technologies, Inc.**]
c. [**Prysmian Cables and Systems; Prysmian Group North America**]
d. [**Radix Wire**]
e. [**Remee Wire & Cable; Remee Products Corporation**]
f. [**Southwire Company, LLC**]
g. [**West Penn Wire; brand of Belden, Inc.**]
h. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
    b. Vertical-Tray Flame Test: UL 1685.
    c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.

4. Standard Features:

    a. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
    b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

E. UL HNIR - Power-Limited Fire-Alarm Plenum Cable (FPLP) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Comtran Corporation**]
    b. [**Genesis; Resideo Technologies, Inc.**]
    c. [**Prysmian Cables and Systems; Prysmian Group North America**]
    d. [**Radix Wire**]
    e. [**Southwire Company, LLC**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. [**West Penn Wire; brand of Belden, Inc.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Comtran Corporation**]
    b. [**Genesis; Resideo Technologies, Inc.**]
    c. [**Prysmian Cables and Systems; Prysmian Group North America**]
    d. [**Radix Wire**]
    e. [**Southwire Company, LLC**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. [**West Penn Wire; brand of Belden, Inc.**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
    b. Vertical-Tray Flame Test: UL 1685.
    c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.
    d. Plenum Rating: NFPA 262[**and New York City Electrical Code**].

4. Standard Features:

    a. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
    b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

F. UL HNIR - Power-Limited Fire-Alarm Riser Cable (FPLR) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Comtran Corporation**]
    b. [**Genesis; Resideo Technologies, Inc.**]
    c. [**Prysmian Cables and Systems; Prysmian Group North America**]
    d. [**Radix Wire**]
    e. [**Southwire Company, LLC**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. [**West Penn Wire; brand of Belden, Inc.**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Comtran Corporation**]
    b. [**Genesis; Resideo Technologies, Inc.**]
    c. [**Prysmian Cables and Systems; Prysmian Group North America**]
    d. [**Radix Wire**]
    e. [**Southwire Company, LLC**]
    f. [**Superior Essex Inc.; subsidiary of LS Corp.**]
    g. [**West Penn Wire; brand of Belden, Inc.**]
    h. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
    b. Vertical-Tray Flame Test: UL 1685.
    c. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.
    d. Riser Rating: UL 1666.

4. Standard Features:

    a. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
    b. Minimum Conductor Size: [**18 AWG**][**16 AWG**][**14 AWG**][**12 AWG**].

G. UL HNIR and FHJR - Fire-Resistive Circuit Integrity Power-Limited Fire-Alarm Plenum Cable (FPLP-CI) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Radix Wire**]
    c. [**VITALink; Omni Cable**]
    d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Radix Wire**]
c. [**VITALink; Omni Cable**]
d. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
b. Vertical-Tray Flame Test: UL 1685.
c. Fire-Resistive Circuit Integrity "CI" Marking: UL CCN FHJR; including UL 2196.
d. Plenum Rating: NFPA 262[**and New York City Electrical Code**].

4. Standard Features:

a. Twisted, shielded pair.
b. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
c. Conductor Size: [**Not smaller than**][**16 AWG**]<**Insert wire size**>[**Size recommended by manufacturer's published instructions**].

5. Other Available Features Required by Project:

a. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.

H. UL HNIR and FHJR - Fire-Resistive Circuit Integrity Power-Limited Fire-Alarm Riser Cable (FPLR-CI) :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Belden Inc.**]
b. [**Comtran Corporation**]
c. [**Radix Wire**]
d. [**VITALink; Omni Cable**]
e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Belden Inc.**]
b. [**Comtran Corporation**]
c. [**Radix Wire**]
d. [**VITALink; Omni Cable**]
e. <**Insert manufacturer's name**>

3. Listing Criteria:

a. Power-Limited Fire-Alarm Cable: UL CCN HNIR; including UL 1424 and Article 760 of NFPA 70.
b. Vertical-Tray Flame Test: UL 1685.
c. Fire-Resistive Circuit Integrity "CI" Marking: UL CCN FHJR; including UL 2196.
d. Riser Rating: UL 1666.

4. Standard Features:

    a. Twisted, shielded pair.
    b. [**Solid**][**Stranded**] copper conductors with 300 V rated, 75 deg C, color-coded insulation.
    c. Conductor Size: [**Not smaller than**][**16 AWG**]<**Insert wire size**>[**Size recommended by manufacturer's published instructions**].

5. Other Available Features Required by Project:

    a. Limited Smoke "ST1" Marking: UL 1685 or UL 2556.

I. UL QAYK - Optical-Fiber Cable for Fire-Alarm Systems :

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Belden Inc.**]
    b. [**Corning Optical Communications; Corning Incorporated**]
    c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Belden Inc.**]
    b. [**Corning Optical Communications; Corning Incorporated**]
    c. <**Insert manufacturer's name**>

3. Listing Criteria:

    a. Optical-Fiber Cable: UL CCN QAYK; including UL 1651, TIA-568.3, and Article 770 of NFPA 70.
    b. Vertical-Tray Flame Test: UL 1685.
    c. Riser Rating: UL 1666.

4. Standard Features:

    a. Single-mode OS2.
    b. Nonconductive.
    c. Glass core with glass cladding.

5. Other Available Features Required by Project:

    a. Limited Smoke "ST1" Marking: UL 1685.
    b. Halogen-Free "HF" Marking: UL Subject 2885.

2.28 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing fire detection and alarm system components, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Smoke Detectors: <**Insert quantity**>.
2. Heat Detectors: <**Insert quantity**>.
3. Duct Smoke Detectors: <**Insert quantity**>.
4. Manual Fire-Alarm Boxes: <**Insert quantity**>.
5. Addressable Input Modules: <**Insert quantity**>.
6. Addressable Output Modules: <**Insert quantity**>.
7. Audible Notification Appliances: <**Insert quantity**>.
8. Visual Notification Appliances: <**Insert quantity**>.
9. Combination Audible/Visual Notification Appliances: <**Insert quantity**>.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to fire detection and alarm system, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Keys for control equipment cabinets.
2. Keys for remote test switches.
3. Wrench for manual fire-alarm boxes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine field conditions with Installer present for compliance with requirements for fire detection and alarm systems and other conditions affecting performance of the Work.

B. Examine all materials, products, and equipment received for defects or damage.

C. Reject all materials, products, and equipment that show signs of defects or damage.

D. Examine roughing-in for fire detection and alarm system piping to verify actual locations of piping connections before equipment installation.

E. Examine walls, floors, ceilings, and roofs for suitable conditions where fire detection and alarm system components will be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CABLING FOR FIRE ALARM

A. Field Circuits:

1. SLC: 12 to 18 AWG [**unshielded**][**twisted pair**][**FPL**][**FPLR**][**FPLP**][**FPLR-CI**][**FPLP-CI**].
2. NAC: 12 to 18 AWG [**unshielded**][**shielded**][**twisted pair**][**FPL**][**FPLR**][**FPLP**][**FPLR-CI**][**FPLP-CI**].
3. Audio Circuits: 12 to 18 AWG [**unshielded**][**shielded**][**twisted pair**][**FPL**][**FPLR**][**FPLP**][**FPLR-CI**][**FPLP-CI**].
4. Auxiliary Power Circuits: 12 to 18 AWG [**unshielded**][**twisted pair**][**FPL**][**FPLR**][**FPLP**].
5. Network Communication Circuits: [**12 to 18 AWG**][**unshielded**][**shielded**][**twisted pair**][**FPLR**][**FPLP**][**FPLR-CI**][**FPLP-CI**][**single-mode fiber-optic cable**].

3.3 SELECTION OF RACEWAYS FOR FIRE ALARM

A. Identification: At a minimum, all junction box covers for fire-alarm raceways must be identified using the color red.

B. Outdoor Pathways:

1. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**].
2. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**]. Locations include the following:

    a. Locations less than 2.5 m (8 ft) above finished grade.
    b. <**Insert designations of applicable spaces or locations**>.

3. Exposed and Not Subject to Physical Damage: [**ERMC**][**IMC**][**Corrosion-resistant EMT**][**RTRC-AG**][**LFMC**][**LFNC**].
4. Marine Locations: [**PVC-80**][**Corrosion-resistant EMT**].
5. Concealed Aboveground: [**ERMC**][**IMC**][**EMT**][**LFMC**].
6. Direct Buried: [**PVC-80**][**HDPE-80**][**LFMC**].
7. Concrete Encased Not in Trench: [**PVC-80**].
8. Concrete Encased in Trench: [**PVC-80**][**HDPE-80**].
9. Innerducts inside Other Raceway: [**ENT**][**RTRC-AG**][**RTRC-BG**][**OFR**][**CR**].

C. Indoor Pathways:

1. Hazardous Classified Locations: [**ERMC**][**IMC**].
2. Exposed and Subject to Severe Physical Damage: [**ERMC**][**IMC**]. Locations include the following:

    a. Loading docks.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums.
    e. <**Insert designations of applicable spaces or locations**>.

3. Exposed and Subject to Physical Damage: [**ERMC**][**IMC**][**EMT**]. Locations include the following:

    a. Locations less than 2.5 m (8 ft) above finished floor.
    b. Stub-ups to above suspended ceilings.
    c. <**Insert designations of applicable spaces or locations**>.

4. Exposed and Not Subject to Physical Damage: [**MC-FPL**][**MC-FPLR**][**MC-FPLP**][**ERMC**][**IMC**][**EMT**][**LFMC**].
5. Concealed above Suspended Ceilings: [**MC-FPL**][**MC-FPLR**][**MC-FPLP**][**ERMC**][**IMC**][**EMT**][**LFMC**][**ERMC**][**IMC**][**EMT**][**LFMC**][**Hooks**].
6. Concealed in Ceilings and Interior Walls and Partitions: [**MC-FPL**][**MC-FPLR**][**MC-FPLP**][**ERMC**][**IMC**][**EMT**][**LFMC**][**ERMC**][**IMC**][**EMT**][**LFMC**][**LFNC**].
7. Damp or Wet Locations: [**ERMC**][**IMC**][**Corrosion-resistant EMT**][**LFMC**][**LFNC**].
8. Innerducts inside Metal Raceway: [**ENT**][**RTRC-AG**][**OFR**][**CR**].
9. Exposed to Environmental Air: [**ERMC**][**IMC**][**EMT**][**PVC-80**].
10. In Vertical Runs: [**ERMC**][**IMC**][**EMT**].

3.4 INSTALLATION OF FIRE DETECTION AND ALARM SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Commissioning of Electrical Systems: NECA NEIS 90.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, NFPA 1225, and NECA NEIS 305.
5. Work in ITE Rooms: NFPA 75.
6. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
7. Life-Safety and Means-of-Egress Work: NFPA 101.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
12. Fire-Alarm Circuits and Pathways: Ch. 12 of NFPA 72 and Article 760 of NFPA 70.
13. Fire-Alarm Initiating Devices: Ch. 17 of NFPA 72.
14. Fire-Alarm Notification Appliances: Ch. 18 of NFPA 72.
15. Fire-Alarm Control Equipment: Ch. 23 of NFPA 72.
16. Fire-Alarm Transmitting Equipment: Ch. 23 and Ch. 26 of NFPA 72.
17. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. <**Insert more stringent installation requirements that supplement or supersede listed standards and manufacturer's published instructions**>.

D. Interfaces with Other Work:

1. Identification: Provide labels for all initiating devices, control equipment cabinets, and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label initiating devices with unique identification.
c. Identify source of AC power inside each control equipment cabinet.
d. Identify circuit disconnecting means at AC power source with red engraved label. Provide approved locking device for circuit disconnecting means.
e. Label enclosures with engraved metal or laminated-plastic nameplate.
f. Identify junction box covers using the color red.
g. Identify <**Insert raceway component**> using the color red.

2. Coordinate installation of new products for <**Insert system or product group/category**> with existing conditions.

a. <**Insert requirements for transition between new and existing**>.

3. Coordinate with <**Insert Section number and title**> for <**Insert description of interfacing related Work**>.

a. <**Insert requirements for transition between this Section and related Work**>.

E. Systems Integration:

1. <**Insert requirements for integration with other systems**>.

3.5 FIELD QUALITY CONTROL OF FIRE DETECTION AND ALARM SYSTEMS

A. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**][**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Acceptance Testing Preparation:

1. <**Insert requirements**>.

C. Field tests and inspections must be witnessed by [**Architect**][**Tenant**][**authorities having jurisdiction**]<**Insert names or titles of witnesses**>.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform system acceptance testing in accordance with Ch. 14[**and Appendix D**] of NFPA 72.
3. Contractor is responsible for completing pre-acceptance testing to verify proper operation of the fire detection and alarm systems. Correct system deficiencies prior to scheduling a final acceptance test.

E. Nonconforming Work:

1. Initiating devices, notification appliances, control equipment, and system accessories will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.6 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Provide power to the FACU and configure internal settings.
3. Test all field wiring prior to connecting field devices and prior to connecting to the FACU. Ensure field wiring is free from ground faults and short circuits.
4. Connect field devices to field wiring.
5. Connect field wiring inside FACU cabinet.
6. Ensure system is normal and free from ground faults, open circuits, or short circuits.

7. Allow system burn-in for [**30**][**60**] days.
8. Correct any issues that occur during the system burn-in period.
9. <**Insert startup steps if any**>.

B. Manufacturer Services: Engage factory-authorized service representative to [**support**][**supervise**] system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.7 PROTECTION

A. After installation, protect fire detection and alarm system equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Maintenance Service Agreement: Beginning at Substantial Completion, verify that maintenance service agreement includes [**three-month**][**six-month**][**nine-month**][**one-year**]<**Insert duration**> period for full maintenance by [**skilled employees of fire detection and alarm system Installer**][**manufacturer's authorized service representative**]. Include [**monthly**][**quarterly**][**semiannual**][**annual**] preventive maintenance, repair, or replacement of worn or defective components; cleaning; and adjusting as required for proper fire detection and alarm system operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

B. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two years**]<**Insert duration**>.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two years**]<**Insert duration**> from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**][**Conduct reacceptance testing of system components directly affected by software and firmware upgrades.**]

    a. Upgrade Notice: Not less than [**30 days**]<**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary**].

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 28 46 00 00

Task	Specification	Specification Description
28 46 00 00	28 10 00 00a	Access Control Software and Database Management
28 46 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 13 00	28 10 00 00a	Access Control Software and Database Management
28 46 13 00	28 46 00 00	Fire Detection and Alarm
28 46 13 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 13 31	28 10 00 00a	Access Control Software and Database Management
28 46 13 31	28 46 00 00	Fire Detection and Alarm
28 46 13 31	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 31 00	28 10 00 00a	Access Control Software and Database Management
28 46 31 00	28 46 00 00	Fire Detection and Alarm
28 46 31 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 31 11	28 10 00 00a	Access Control Software and Database Management
28 46 31 11	28 46 00 00	Fire Detection and Alarm
28 46 31 11	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 41 00	28 10 00 00a	Access Control Software and Database Management
28 46 41 00	28 46 00 00	Fire Detection and Alarm
28 46 41 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 41 11	28 10 00 00a	Access Control Software and Database Management
28 46 41 11	28 46 00 00	Fire Detection and Alarm
28 46 41 11	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 46 41 31	28 10 00 00a	Access Control Software and Database Management
28 46 41 31	28 46 00 00	Fire Detection and Alarm
28 46 41 31	28 40 00 00	Emergency Responder Communications Enhancement System ERCES

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SECTION 28 47 00 00 - MASS NOTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mass notification systems.

B. Products Installed, but Not Furnished, under This Section:

1. <**Insert products identified in "Existing Products to be Modified" Article or "Existing Products to be Removed and Re-Installed" Article**>.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260536 "Cable Trays for Electrical Systems" specifies cable trays referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic-restraint devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 270528 "Pathways for Communications Systems" specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.
9. Section 284600 "Fire Detection and Alarm" for fire-alarm cabling and interfaces with MNS equipment in this Section to create an EVACS.

1.2 DEFINITIONS

A. ATP: Acceptance Test Procedure.

B. Broadcast Media: Loudspeakers, radios, cellular phones, and other media that will carry the selected message to the selected audience.

C. Control Unit: A system component that monitors inputs and controls outputs through various types of circuits.

1. Autonomous Control Unit (ACU): The primary control unit for an in-building mass notification system (MNS).

2. Emergency Communications Control Unit (ECCU): A system capable of sending mass notification messages to individual buildings, zones of buildings, individual outdoor loudspeaker arrays, or zones of outdoor loudspeaker arrays; or a building, multiple buildings, outside areas, or a combination of these.
3. Fire-alarm control unit (FACU).
4. Wireless Control Unit: A component that transmits/receives and processes wireless signals.

D. Emergency Communications System (ECS): A system for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action.

1. Distributed Recipient Mass Notification System (DRMNS): A system meant to communicate directly to targeted individuals and groups that might not be in a contiguous area.
2. Emergency Voice/Alarm Communications System (EVACS): Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as evacuation signals pertaining to an emergency, to the occupants of a building.
3. Mass Notification System (MNS): A system used to provide information and instructions to people in buildings or other spaces using intelligible voice communications and including visual signals, text, graphics, tactile, or other communication methods (in-building MNS); and could have the capability to provide real-time information to outdoor areas and to communicate with other notification systems provided for a campus, region, or global geographic setting (wide-area MNS).

E. High Power Loudspeaker Array (HPLA): A product providing capability for voice and tone communication to large outdoor areas.

F. Local Operator Console (LOC): Equipment used by authorized personnel and emergency responders to activate and operate a mass notification system (MNS).

G. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Power calculations.
4. Battery capacity calculations with the following supporting information:

a. Supervisory power requirements for all equipment.
b. Alarm power requirements for all equipment.
c. Power supply rating.
d. Voltage drop calculations for wiring runs demonstrating worst-case condition.
e. Notification appliance circuit design.

5. Include manufacturer's sample extended warranty language.

B. Shop Drawings: Prepare and submit the following in accordance with NFPA 72:

1. Floor Plans:

a. Scaled floor plans indicating location and unique identification of each component and point-to-point wiring.
b. Indicating all acoustically distinguishable spaces (ADS) where intelligibility is required, and where intelligibility is not required or is not able to be achieved,
c. Elevations indicating equipment dimensions and mounting heights.

2. Wiring Diagrams:

a. System riser diagram, including power, signal, and control wiring.
b. Mass notification system component schematic wiring diagrams.

3. Details:

a. Component installation details.
b. Details of equipment assemblies, including dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Calculations:

a. Battery calculations.
b. Voltage-drop calculations.
c. Spare capacity circuit calculations.

5. Sequence of Operations: Prepare a narrative description or input/output matrix of operation to describe the mass notification system sequence of operation.
6. Applicable Codes and Standards:

a. Indicate on Shop Drawings the applicable referenced codes and standards and their respective edition adopted in the jurisdiction where the project is located.

C. Field quality control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each amplifier and loudspeaker, for tests performed by [**manufacturer and witnessed by a qualified testing agency**] [**a qualified testing agency**].

1.5 CLOSEOUT SUBMITTALS

A. Computer-generated instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Card must indicate those steps to be taken by an operator when a signal is received as well as functional operation of system under all conditions: normal, alarm, supervisory, and trouble.

B. Record Documentation: System documentation to Owner including, but not limited to, the following:

1. System record Drawings and wiring details, including one set of full-size printed Drawings, and CD-ROM with copies of record Drawings in PDF format and DXF format.
2. Documentation of all component and wiring identification, including a copy of each equipment nameplate.
3. System matrix showing interaction of all input signals with output commands.

4. Documentation of system voltage, current, and resistance readings taken during installation, testing, and ATP phases of system installation.

C. System program showing control devices and operations, and system functions of equipment and devices.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for software and firmware upgrades.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

C. Schedule of maintenance material items.

1.7 QUALIFICATIONS

A. Fire-Alarm Systems (FAS) Technician Trainee: Having at least six months of experience and possessing active NICET FAS Level I certification. Able to perform limited tasks under direct supervision.

B. Fire-Alarm Systems (FAS) Associate Engineering Technician: Having at least two years of experience and possessing active NICET FAS Level II certification. Able to review drawings, specifications, codes, and standards; to conduct basic installation activities; and to perform basic troubleshooting.

C. Fire-Alarm Systems (FAS) Engineering Technician: Having at least five years of experience and possessing active NICET FAS Level III certification. Able to perform system layout activities, to supervise Level I and Level II technicians, to provide submittal packages, and to interact with authorities having jurisdiction.

D. Fire-Alarm Systems (FAS) Senior Engineering Technician: Having at least 10 years of experience and possessing active NICET FAS Level IV certification. Able to manage multiple projects at once, to interpret codes and standards, to conduct training, and to serve as liaison between authorities having jurisdiction, owners, engineers, and contractors.

E. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and to prepare related records and reports.

F. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke control interfaces, air sampling systems, multi-zone voice evacuation systems, or high-rise applications) and to prepare related records and reports.

G. Communications Design Professional: Design professional possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Expertise in design of communications infrastructure and distribution equipment.
2. BICSI Registered Communications Distribution Designer (RCDD)[**or Outside Plant Designer (OSP)**] certification.

H. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:

1. Training and manufacturer certification to install, splice, and terminate communications cabling.
2. Installation Supervisor: BICSI Technician (TECH) certification.
3. Copper Installers: [**30 percent**] <**Insert quantity**> of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
4. Fiber Installers: [**30 percent**] <**Insert quantity**> of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

I. Communications Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have [**BICSI Technician (TECH)**] <**Insert certification program**> certification and documented training, and be experienced with testing communications equipment in accordance with [**BICSI**] <**Insert code enforced by authorities having jurisdiction**> testing standards.

J. Life-Safety Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in life-safety systems.

K. Fire-Alarm Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate fire-alarm cabling.

1. On-site fire-alarm cable installation supervisor must possess active NICET FAS [**Senior**]Engineering Technician certification.

L. Fire-Alarm Testing Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician [**I**] [**II**] certification.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that installed MNS performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: [**Two**] [**Three**] [**Four**] <**Insert number**> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that MNS performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Initial Extended-Warranty Period: [**Three**] [**Four**] [**Five**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: [**Eight**] <**Insert number**> years from date of Substantial Completion; [**full**] [**prorated**] coverage for materials only, free on board [**origin**] [**destination**], freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.2 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

A. Basis for Pricing: <**Insert name of manufacturer; model number or series for existing product**>.

B. Description: <**Insert description of existing product, including special features, options, and finishes that may impact the Work**>.

C. Accessories: <**Insert accessories included with existing product**>.

2.3 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with Article 760 of NFPA 70 and Ch. 24 of NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. General Characteristics:

1. ECS Classification: [**One-way, in-building EVACS**] [**One-way, in-building MNS**] [**One-way, wide-area MNS**] [**One-way DRMNS**].
2. Provide the following specified products with the MNS:

    a. ACU.
    b. Prerecorded message device.
    c. Audio amplifiers.
    d. Audible signaling devices.
    e. Indoor speakers for voice notification.
    f. Outdoor HPLAs.
    g. Text displays.
    h. Visual signaling devices for hearing impaired.
    i. Web interfaces.
    j. Overvoltage and surge protection.
    k. LOCs.
    l. Software.

3. Software-operated, network-based communications system with wired and wireless access points for control interface. Designated operators must be able to log in via a web browser and have complete access to their own portion of MNS.
4. ACU must monitor and control the notification appliance network and provide consoles for local operation. Authorized personnel must be able to use a console to initiate delivery of prerecorded voice messages, provide live voice messages and instructions, and initiate visual strobe and optional textual message notification appliances. ACU must override audible fire-alarm notification signals and voice messages based on the approved sequence of operation described in the risk analysis.
5. MNS messaging system must be capable of the following:

    a. Communicating through use of wired networks, or wireless networks via wireless control units, for one- or two-way communications and control between a building or area and emergency personnel.
    b. Automatically distribute no fewer than 100 simultaneous and unique messages to appropriate notification appliances.
    c. Allow multiple operators to send messages simultaneously.
    d. Grant access for control to another control station if location in control becomes inoperable and/or authorized operator at that control station can no longer operate the control station.
    e. Send voice messages and text messages with an indication of the source of message that can only be sent from message source.
    f. Send alert messages to end users (recipients) via multiple delivery methods including, but not limited to, the following:

        1) Audio-visual network alerts to computers via desktop pop-up.
        2) Text alerts to cellular phones and pagers.
        3) Text alerts to email clients.
        4) Text alerts to textual visible appliances.
        5) Alerts to visible appliances.
        6) Audio alerts to phones.
        7) Audio alerts to loudspeakers.
        8) Audio alerts to existing wide-area or in-building ECS.
        9) Network alerts to other IP-connected devices via standard XML and CAP protocols.

    g. Suppress contact information for other end users with messages or in message headers.

6. Live announcements or prerecorded messages. Live messages must take precedence over prerecorded messages.
7. Notification appliance network must consist of loudspeakers and visual notification devices located to provide intelligible instructions at all ADS designated by designer to receive messages. [**Areas as indicated on Drawings**] <**Insert locations**>.
8. Interface with FACU to use voice modules, visual alarms, and loudspeakers of fire-alarm system.
9. Give priority to MNS announcements over other audible announcements of the system including fire-alarm system in a normal or alarm state based on the approved risk analysis. When an emergency announcement other than fire is activated during a fire alarm, fire-alarm system functions must continue in an alarm state, except for output signals of fire-alarm audible and visual notification appliances.
10. Comply with speech intelligibility requirements of NFPA 72.
11. Capable of overriding local control of loudspeaker volume levels for emergency communications. Local controls must be permitted to adjust volume levels of non-emergency signals only, such as, but not limited to, background music and convenience paging.
12. Capable of providing separate messages to one individual building or to multiple buildings at given time if MNS serves more than one building.
13. Capable of monitoring emergency notifications from multiple data sources (National Weather Service, Emergency Managers Weather Information Network, Naval Meteorology and

Oceanography, and others as determined locally) and automatically send out notifications to designated facilities and personnel based on predefined rules.

14. Capable of centrally tracking, in real-time, all alerting activities for each individual recipient, including sending, receiving, and responding to alerts, and of generating reports based on tracked information.
15. Capable of operating remote printer via USB output. Provide matching printer listed and labeled as part of MNS.
16. Primary Power: Must be sized to supply not less than 125 percent of the total connected load in a worst-case condition.

    a. Devices Powered by 24 V(dc):

        1) Control units.
        2) Notification appliances.
        3) Text displays.
        4) Trouble signals.
        5) Supervisory signals.
        6) Supervisory and digital alarm communicator transmitters.
        7) Digital alarm radio transmitters.

17. Secondary Power: Must be sized to supply not less than 125 percent of the total connected load in a worst-case condition.

    a. Batteries: [**Sealed lead calcium**] [**Sealed, valve-regulated, recombinant lead acid**] [**Sealed lead-calcium, valve-regulated, recombinant lead acid**].

2.4 MASS NOTIFICATION SYSTEMS

A. UL PGWM - Autonomous Control Units (ACUs) <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

    a. Fully enclosed in a lockable steel cabinet with access for testing, and maintenance from the front of enclosure.
    b. Solid-state, modular components, internally mounted and arranged for easy access for power, supervision, control, and logic for system.
    c. 120 V ac, 60 Hz power supply.
    d. An indicator for each message source must indicate which sources are available and which are selected.
    e. Indicators for broadcast media used to convey the selected message to selected audience must indicate which sources are available and which are selected.
    f. Capable of confirming receipt of a message. If message was not confirmed received, system must be capable of using other means of contact until receipt of confirmation or until a preset time has elapsed.
    g. Capable of automatically sending another message after receipt of a new information or messages.

h. Operator Access Functions:

1) Select prerecorded message for transmission.
2) Select microphone for live broadcast.
3) Initiate message broadcast.
4) Terminate message broadcast.

i. Supervisory Access Functions:

1) Reset time and date.
2) Enable or disable printouts, initiators, and event-initiated programs.
3) Enable or disable individual message sources and broadcast media.
4) Supervisory level functions must not require computer programming skills. MNS must record changes to program functions, to be maintained in ACU for a minimum of [**one year**] <**Insert time**>. ACU must maintain the ID of supervisor making the change.

j. System Operator Level Access Functions:

1) Clear supervisory trouble alarms.
2) Revise programming.
3) Revise prerecorded messages.
4) Assign access rights to all levels.
5) MNS must record changes at system operator level in ACU, to be maintained for a minimum of [**one year**] <**Insert time**>. ACU must maintain the ID of system operator making the change.

k. Capable of no fewer than [**1000**] [**5000**] <**Insert number**> users, with each user having its own log-in and password credentials and no fewer than four contact methods.
l. Capable of storing users in one or multiple groups and able to create a minimum of [**10**] [**20**] <**Insert number**> groups.
m. Each panel must have supervisory functions for power failure, internal component failure, and operation.
n. MNS must have complete set of self-diagnostics for controller and appliance network, and local diagnostic information display, local diagnostic information, and system event log.
o. Printed records of changes, supervisory functions, message transmission, and operator actions must be maintained for a minimum of [**one year**] <**Insert time**>.

B. UL PGWM - Prerecorded Message Devices <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

a. Description: Hardware that stores and outputs audible signals or messages.
b. One-way, multichannel voice notification system incorporating no fewer than eight distinct sounds selectable by user for tone signaling and incorporating a voice module for delivery of prerecorded or live messages.
c. Redundant microphones, preamplifiers, amplifiers, and tone generators provided in separate main and remote cabinets.

d. Voice notification system must support facility-wide public address paging.
e. Audible appliances must produce an initial message stating "May I have your attention please?" followed by a voice message with instructions as defined by the risk analysis that is repeated until ACU is reset or silenced. If the intent is for building or floor evacuation, the standard temporal pattern complying with ASA S3.41 will follow the message.
f. Automatic messages must be broadcast through loudspeakers throughout the building or facility, but not in stairs or elevators.
g. When using microphones, live messages must be broadcast throughout a selected floor or floors or all call, including stairs and elevators.
h. Loudspeakers must not be installed in near a microphone that will be used for live messaging.
i. Live voice message must override automatic or recorded audible output through use of a microphone input at ACU or the remote cabinet.
j. Number of alarm channels must be indicated for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone.

1) Allow sending an evacuation signal to selected zones and, concurrently, allow voice paging to other zones selectively or in combination.
2) Programmable tone and message sequence selection.
3) Standard digitally recorded messages for "Evacuation" and "All Clear."

C. UL UUMW - Audio Amplifiers <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Amplifiers for Fire-Protective Signaling Systems: UL CCN UUMW, including UL 1711 and ISO 7240.

4. Standard Features:

a. Audio output must be selectable for line level. Minimum amplifier output must be [**100**] <**Insert number**> W rms.
b. Capable of operating all loudspeakers at the same time[**with fiber connection**].
c. Loss of operating power, supervisory power, or other malfunction that could render the voice module inoperative must automatically cause the standard temporal tone pattern complying with ASA S3.41 to take over all functions assigned to failed unit in the event an alarm is activated.

D. UL ULSZ - Audible Signaling Devices <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Sounding Devices: UL CCN ULSZ, including UL 464.

4. Standard Features:

a. Handheld push-to-talk microphone must be supervised and a key must be required to enable remote microphone use.
b. Microprocessor must actively integrate circuitry, field wiring, and digital coding necessary for immediate and accurate rebroadcasting of stored voice data into appropriate amplifier input.

E. UL UUMW - Indoor Loudspeakers for Voice Notification <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Loudspeakers for Fire-Protective Signaling Systems: UL CCN UUMW, including UL 1480.

4. Standard Features:

a. Construction: High-efficiency, sealed back; for maximum output at minimum power across a frequency range of 150 to 10 000 Hz.
b. High-Range Units: Rated 2 to 15 W.
c. Low-Range Units: Rated 1 to 2 W.
d. Mounting: [**Flush**] [**or**] [**semi-recessed**] [**or**] [**surface mounted and bidirectional**].
e. Matching Transformers: Tap range matched to acoustical environment of loudspeaker location.

F. UL UUMW - High Power Loudspeaker Arrays (HPLAs) <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Loudspeakers for Fire-Protective Signaling Systems: UL CCN UUMW, including UL 1480.

4. Standard Features:

a. HPLAs, [**1600**] [**3200**] W, with acoustic performance and intelligibility features.
b. Sound Dispersion: [**Omnidirectional**] [**Horizontal 70 degrees, vertical 80 degrees**].
c. Control unit providing signal processing, amplification, gain control, battery backup, and antenna surge protection.
d. Pole designed for HPLA with wind load of [**100 mph (160 km/h)**] [**110 mph (177 km/h)**] <**Insert value**>.

5. Seismic and Wind Performance for Outdoor HPLAs: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

a. Supporting structure must be sized to accommodate the static and dynamic loads produced by the sound systems and all attachments.
b. Minimum design wind speed of [**100 mph (161 km/h)**] <**Insert other wind speed requirement**>.
c. Seismic design in accordance with site-specific requirements.
d. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events[**and unit must be fully operational after seismic events**]."

e. Component Importance Factor (I_p): [**1.0**] [**1.5**].
f. Component Amplification Factor (a_p): [**1.0**] [**2.5**] <**Insert value**>.
g. Component Response Modification Factor (R_p): [**1.5**] [**2.0**] [**2.5**] [**6.0**] <**Insert value**>.
h. Component Overstrength Factor (Ω_o): [**1.5**] [**2.5**] <**Insert value**>.

G. UL UVAV - Text Displays <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Visual-Signal Appliances for Fire-Protective Signaling Systems: UL CCN UVAV, including UL 1638.

4. Standard Features:

   a. Indicate location of digital displays on Drawings.
   b. Programmable, digital text displays having a minimum of 4 inch (100 mm) high letters for hearing-impaired occupants displaying content of voice message being played.
   c. Capable of sending static, flashing, or scrolling messages to textual visible appliances.
   d. ACU must interface with and control the programmable display controller to activate the proper message.
   e. Textual visible notification must be primary notification when it is the only method used to convey emergency MNS information to general public or to specific individuals.

H. UL UUKC - Visual Signaling Devices for Hearing Impaired <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Signaling Appliances and Equipment for Hearing Impaired: UL CCN UUKC, UL 1971.

4. Standard Features:

   a. Strobes used solely for MNS must be [**amber**] [**clear**], comply with UL 1971, and have the word "ALERT" factory printed on the trim.
   b. Strobes used in combination systems, where the same strobe is used for both MNS and fire-alarm notification, must be clear and comply with UL 1971.
   c. Strobes used for MNS must be synchronized in accordance with requirements of NFPA 72.

I. UL PGWM - Web Interfaces <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

   a. Description: Systems hardware capable of using dedicated or existing IP networks to send alert messages.
   b. System must be able to communicate with multiple modalities to include, but not be limited to, pop-up alerts on PCs, text messages to cellular phones, email messaging to IP-capable computers or devices, and recorded voice messages to VoIP telephones and PCs.
   c. Capable of activating, through single interface, non-IP alerting systems such as wide-area alerting systems, fire-alarm systems, public address systems, handheld radio systems, radio broadcast systems, personal pager systems, nurse call systems, and traditional dial-up telephone alerting systems.

5. Other Available Features Required by the Project:

   a. Capable of accessing user screens via multiple web browsers such as Microsoft Explorer, Mozilla Firefox, or Apple Safari.
   b. Capable of sending live video stream from IP-based camera or security camera system to PC or video display.

J. UL QVGQ - Signaling Line Circuit Surge Protection <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Isolated Loop Circuit Protectors: UL CCN QVGQ, including UL 497B.

4. Standard Features:

   a. Protected against surges induced on signaling line circuit located outdoors.
   b. Protect cables and conductors that serve as communications links with surge protection devices installed at each end that comply with the following waveforms:

      1) 10 by 1000-microsecond waveform with a peak of 1500 V and a peak current of 60 A.
      2) 8 by 20-microsecond waveform with a peak of 1000 V and a peak current of 500 A. Protection must be provided at the equipment. Additional surge protectors, rated for application, must be installed on each circuit within 36 inch (900 mm) of the cable entrance to building.

   c. Fuses must not be used for surge protection.

K. UL QVRP2 - Sensor Wiring Surge Protection <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Secondary Protectors for Communications Circuits Used with Specified Voltage Suppression - Component: UL CCN QVRP2, including UL 497A and UL Subject 497D.

4. Standard Features:

a. Digital and analog inputs and outputs must be protected against surges induced by sensor wiring. Inputs and outputs must be tested with the following waveforms:

1) 10 by 1000-microsecond waveform with a peak of 1500 V and a peak current of 60 A.
2) 8 by 20-microsecond waveform with a peak of 1000 V and a peak current of 500 A.

b. Fuses must not be used for surge protection.

L. UL PGWM - Local Operator Consoles (LOCs) <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

a. Description: Remote message initiation console.
b. Capable of initiating recorded messages and displays, and for delivering live voice messages.
c. Capacity for no fewer than [**eight**] <**Insert number**> prerecorded messages and ability to automatically repeat prerecorded messages.
d. Having a microphone for delivering live messages.
e. FACU Interface: Adequate discrete outputs to temporarily deactivate the fire-alarm audible notification appliances while delivering voice messages.
f. LOC must be capable of being locked out or overridden from ACU.

5. Other Available Features Required by the Project:

a. Provide redundant control of ACU.
b. When an installation has more than one LOC, LOCs must be programmed to allow only one LOC at a time to be available for messaging. Once one LOC becomes active, all other LOCs will have an indication that the system is busy (Amber Busy Light) and cannot be used at that time.

M. UL PGWM - Software <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Control and Communication Equipment: UL CCN PGWM, including UL 2572.

4. Standard Features:

a. Description: PC-based equipment that is field programmable for control, notification, and supervisory functions; menu-driven program configuration; password protected.
b. Loading and editing instructions and operating sequences as necessary.
c. Storing and downloading while the system is in operation.

d. Second set of operating software must reside in control units as backup if primary operating software is corrupted.
e. Allows [**10 to 50**] <**Insert range**> remote users.
f. Operating system used must be compatible with manufacturer software operating system.
g. Memory: Software operations must be stored in nonvolatile programmable memory within MNS control unit. Loss of primary and secondary power must not erase nonvolatile programmable memory.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing MNS, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Loudspeakers: Quantity equal to [**five**] <**Insert number**> percent of quantity installed[**for each type indicated**], but no fewer than [**one**] <**Insert number**> unit(s).
2. Fuses: [**Two**] <**Insert number**> of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to MNS, that are packaged with protective covering for storage on-site and identified with labels describing contents.[**Include the following:**]

1. Software, connecting cables, and proprietary equipment necessary for maintenance, testing, reprogramming, and implementing future changes to MNS. Tools listed by part number in operation and maintenance manuals are considered special tools.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Commissioning of Electrical Systems: NECA NEIS 90.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Fire-Alarm and Premises Security Work: NFPA 72, NFPA 731, NFPA 1225, and NECA NEIS 305.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Communications Work: BICSI N1.
7. Work in ITE Rooms: NFPA 75.
8. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
9. Life Safety and Means of Egress Work: NFPA 101.

10. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
11. Work in Confined Spaces: NFPA 350.
12. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
13. Work in Museums, Libraries, Places of Worship, and Historic Structures: NFPA 909 and NFPA 914.
14. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install remote amplification and control units in terminal cabinets. Power each remote amplification and control unit from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as remote unit.
2. Equipment Installation: Install MNS cabinets with seismic-restraint devices, seismic-rated anchors, and mounting apparatus.
3. Provide rated fire-alarm cables and conductors for MNS.
4. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

    a. Install plenum cable in environmental airspaces, including plenum ceilings and in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring is used.
    b. Install cables in cable trays where indicated on the Drawings.
    c. Provide raceways and boxes for cables.
    d. Conceal conductors and cables in accessible ceilings, walls, and floors where possible. Suspend cable not in a wireway or pathway a minimum of 8 inch (200 mm) above ceiling by cable supports not more than [**60 inch (1500 mm)**] <**Insert dimension**> apart.
    e. Do not install cable through structural members or in contact with pipes, ducts, or other potentially damaging items.
    f. Secure and support cables at intervals not exceeding 30 inch (750 mm) and not more than 6 inch (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
    g. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's written limitations on bending radii. Maintain separation of conductor types as recommended by manufacturer. Install lacing bars and distribution spools.
    h. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
    i. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamp use is prohibited.
    j. Separation of Wires: Separate loudspeaker-microphone, line-level, loudspeaker-level, and power wiring runs. Install MNS wiring in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inch (300 mm) apart for loudspeaker-microphone wiring and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
    k. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Install lacing bars and distribution spools. Route conductors to allow accessibility to equipment for adjustment and maintenance.
    l. Connections:

        1) Make all terminations on numbered terminal strips in terminal cabinets or equipment enclosures. No splices or butt joints will be accepted.
        2) Terminate all conductors; no cable must contain unterminated elements.

3) Crimp-on spade lugs must be used for terminations of stranded conductors to binder screw or stud terminals. Spade lugs must have upset legs and insulation sleeves sized for conductors.

5. Mount all devices and appliances to or in an approved electrical box.
6. Install operating instruction placard on the interior of ACU.
7. Install operating instruction placard on the frame in location acceptable to Architect and observable from ACU.
8. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
9. Cybersecurity:

a. Software:

1) Coordinate security requirements with [**IT department**] [**CIO**] <**Insert entity responsible for IT security**>.
2) Ensure that latest stable software release is installed and properly operating.
3) Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols no fewer than eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

b. Hardware:

1) Coordinate location and access requirements with [**IT department**] [**CIO**] <**Insert entity responsible for IT security**>.
2) Enable highest level of wireless encryption that is compatible with Owner's ICT network.
3) Disable dual network connections.

D. Interfaces with Other Work:

1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Signal Ground Terminal: Locate at main equipment cabinet. Connect to instrument ground system and isolate from power system and equipment grounding.
3. Identification: Provide labels for mass notification appliances and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure with engraved metal or laminated-plastic nameplate.
c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
d. Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
e. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.
f. Install framed instructions in a location visible from mass notification control unit.

3.3 FIELD QUALITY CONTROL

A. Administrant for Communications Tests and Inspections:

1. [**Owner**] [**Tenant**] will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.

3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

B. Administrant for Fire-Alarm Tests and Inspections:

1. [**Owner**] [**Tenant**] will engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified fire-alarm testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Acceptance Testing Preparation:

1. Prepare a written ATP for testing MNS components and installation in accordance with NFPA 72 and this Section. Demonstrate specified function of system and verify the correct operation of all system components, circuits, and programming.
2. Prepare a complete listing of device labels for alphanumeric annunciator displays prior to ATP.
3. Schedule tests with no fewer than [**seven**] <**Insert number**> days' advance notice of test performance.

D. Field tests must be witnessed by [**Architect**] [**authorities having jurisdiction**] <**Insert names or titles of witnesses**>.

E. Tests and Inspections:

1. Take resistance, current, and voltage readings as work progresses.
2. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Perform additional tests specified in Section 260526 "Grounding and Bonding for Electrical Systems."
3. Verify that wiring for each device is terminated at properly identified terminals.
4. Test wiring runs for continuity, short circuits, and grounds before system is energized.
5. All test equipment, instruments, tools, and labor required to conduct system tests must be made available by installing Contractor. The following equipment must be a minimum for conducting tests:

    a. Ladders and scaffolds as required to access all installed equipment.
    b. Multi-meter for reading voltage, current, and resistance.
    c. Two-way radios and flashlights.
    d. Decibel meter.
    e. In addition to testing specified to be performed by installing Contractor, installation must be subject to test by [**Owner**] [**Architect**] [**Construction Manager**].

6. After installing MNS and after electrical circuitry has been energized, test for compliance with requirements.
7. Perform tests in [**all**] [**50 percent of**] [**25 percent of**] <**Insert quantity**> zones and rooms[**as indicated on Drawings**].
8. Perform indoor sound tests in a single test location in rooms less than 20 by 20 ft (6 by 6 m). Tests must be made on a 20 by 20 ft (6 by 6 m) grid for larger rooms.
9. Sound level measurements must be taken at a worst-case location within each room or grid, not near loudspeakers.

10. Operational Test: Perform tests that include originating messages at microphone outlets, prerecorded messages, [**remote wired and non-wired inputs**] [**telephone**] [**cellular**] and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
11. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000 Hz signal. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

12. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12 000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
13. Intelligibility Test: Test for intelligibility in accordance with NFPA 72. See Annex D of NFPA 72 for additional guidance on speech intelligibility testing.
14. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12 000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB. Outdoor sound levels where personnel may be present must not exceed 120 dB(A-weighted) when measured on the A-scale of a standard sound level meter at slow response. Sound levels must not exceed 85 dB(A-weighted) at local microphone of MNS under the same conditions.
15. System notification appliances must be demonstrated as follows:

    a. All alarm notification appliances actuate as programmed.
    b. Audibility and visibility at required levels.
    c. Messages are intelligible in all areas.

16. System indications must be demonstrated as follows:

    a. Correct message display at MNS ACU for each alarm input.
    b. Correct message display at remote panels and annunciators for each alarm input.
    c. Correct history logging for all system activity.

17. System off-site reporting functions must be demonstrated as follows:

    a. Correct zone transmitted for each alarm input.
    b. Trouble signals received.

18. <**Insert additional tests and inspections**>.

F. Nonconforming Work:

1. MNS will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

G. Field Quality Control Reports: Collect, assemble, and submit test and inspection reports.

H. Manufacturer Services: Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 CLOSEOUT ACTIVITIES

A. Demonstration:

1. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain units.

    a. Train a minimum of [**four**] <**Insert number**> employees of Owner.
    b. Conduct training on installed equipment after acceptance testing.
    c. Train on system operation, including manual control of output functions from ACU.
    d. Train on testing of system, including logging of system tests, field test of devices, and response to common troubles.
    e. Total training requirement must be a minimum of [**four**] <**Insert number**> hours but must be sufficient to cover all items specified.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for [**two years**] <**Insert duration**>.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within [**two years**] <**Insert duration**> from date of Substantial Completion.[**Verify that upgrading software includes operating system and new or revised licenses for using software.**]

    a. Upgrade Notice: Not less than [**30 days**] <**Insert duration**>; to allow Owner to schedule and access the system[**and to upgrade computer equipment if necessary.**]

3. Field Reports for Software and Firmware Upgrades: Prepare and submit report after each update, documenting upgrades installed.

END OF SECTION 28 47 00 00

Task	Specification	Specification Description
28 47 00 00	28 10 00 00a	Access Control Software and Database Management
28 47 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 15 00	28 10 00 00a	Access Control Software and Database Management
28 47 15 00	28 47 00 00	Mass Notification
28 47 15 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 17 00	28 10 00 00a	Access Control Software and Database Management
28 47 17 00	28 47 00 00	Mass Notification
28 47 17 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 17 17	28 10 00 00a	Access Control Software and Database Management
28 47 17 17	28 47 00 00	Mass Notification
28 47 17 17	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 21 00	28 10 00 00a	Access Control Software and Database Management
28 47 21 00	28 47 00 00	Mass Notification
28 47 21 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 47 21 21	28 10 00 00a	Access Control Software and Database Management
28 47 21 21	28 47 00 00	Mass Notification
28 47 21 21	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 49 00 00	28 10 00 00a	Access Control Software and Database Management
28 49 00 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 49 11 00	28 10 00 00a	Access Control Software and Database Management
28 49 11 00	28 16 11 00	Intrusion Detection
28 49 11 00	28 16 11 00a	Area and Perimeter Intrusion Detection
28 49 11 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 49 17 00	28 10 00 00a	Access Control Software and Database Management
28 49 17 00	28 40 00 00	Emergency Responder Communications Enhancement System ERCES
28 00 00 00MOD000	28 10 00 00a	Access Control Software and Database Management

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SECTION 31 05 13 00 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipes and fittings.
2. Drainage conduits.
3. Drainage panels.
4. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 (DN 150) and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 (DN 200) and Larger: ASTM F667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Airfield Systems, LLC**]
b. [**American Wick Drain Corporation (AWD)**]
c. [**JDR Enterprises, Inc**]
d. [**MAPEI Corporation**]
e. [**TenCate Geosynthetics**]
f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Airfield Systems, LLC**]
    b. [**American Wick Drain Corporation (AWD)**]
    c. [**JDR Enterprises, Inc**]
    d. [**MAPEI Corporation**]
    e. [**TenCate Geosynthetics**]
    f. <**Insert manufacturer's name**>

3. Nominal Size:

    a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
    b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: PP geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D1248 and wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Varicore Technologies, Inc.**]
    b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Varicore Technologies, Inc.**]
    b. <**Insert manufacturer's name**>

3. Nominal Size:

    a. 6 Inches (152 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**15 gpm (57 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
    b. 12 Inches (305 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
    c. 18 Inches (457 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven, needle-punched geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

6. Couplings: HDPE.

C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D3350 and wrapped in geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Drainage Systems, Inc**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Drainage Systems, Inc**]
   b. <**Insert manufacturer's name**>

3. Nominal Size:

   a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**30 gpm (114 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of [**45 gpm (170 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: PP geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.
6. Couplings: Corrugated HDPE band.

D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Advanced Building Products Inc.**]
   b. [**Low & Bonar PLC**]
   c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Advanced Building Products Inc.**]
   b. [**Low & Bonar PLC**]
   c. <**Insert manufacturer's name**>

3. Nominal Size: **6 inches (150 mm)** high by approximately **0.9 inch (23 mm)** thick.

   a. Minimum In-Plane Flow: [**2.4 gpm (9.1 L/min.)**]<**Insert value**> at hydraulic gradient of

[**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Invisible Structures, Inc.**]
   b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Invisible Structures, Inc.**]
   b. <**Insert manufacturer's name**>

3. Nominal Size:

   a. 18 Inches (0.5 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of [**82 gpm (310 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.
   b. 36 Inches (1 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of [**164 gpm (621 L/min.)**]<**Insert value**> at hydraulic gradient of [**1.0**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

2.3 DRAINAGE PANELS

A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, [**36 to 60 inches (915 to 1525 mm)**]<**Insert dimensions**> wide with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**American Wick Drain Corporation (AWD)**]
   b. [**Dorken Systems Inc.**]
   c. [**Eljen Corporation**]
   d. [**JDR Enterprises, Inc**]
   e. [**MAPEI Corporation**]
   f. [**Mar-flex Waterproofing & Building Products**]
   g. [**Midwest Diversified Technologies Incorporated**]
   h. [**Sika Greenstreak**]

i. [**TenCate Geosynthetics**]
j. [**Thrace-LINQ, Inc.; Thrace Group**]
k. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**American Wick Drain Corporation (AWD)**]
b. [**Dorken Systems Inc.**]
c. [**Eljen Corporation**]
d. [**JDR Enterprises, Inc**]
e. [**MAPEI Corporation**]
f. [**Mar-flex Waterproofing & Building Products**]
g. [**Midwest Diversified Technologies Incorporated**]
h. [**Sika Greenstreak**]
i. [**TenCate Geosynthetics**]
j. [**Thrace-LINQ, Inc.; Thrace Group**]
k. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.

a. Minimum Compressive Strength: [**10,000 lbf/sq. ft. (479 kPa)**][**15,000 lbf/sq. ft. (718 kPa)**][**18,000 lbf/sq. ft. (862 kPa)**][**21,000 lbf/sq. ft. (1005 kPa)**]<**Insert value**> when tested in accordance with ASTM D1621.
b. Minimum In-Plane Flow Rate: [**2.8 gpm/ft. (35 L/min. per m)**][**7 gpm/ft. (87 L/min. per m)**][**15 gpm/ft. (186 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and compressive stress of [**25 psig (172 kPa)**]<**Insert value**> when tested in accordance with ASTM D4716.

4. Filter Fabric, Nonwoven: Needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:

a. Survivability: [**Class 1**][**Class 2**][**Class 3**].
b. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.25-mm)**][**No. 70 (0.212-mm)**] sieve, maximum.
c. Permittivity: [**0.5**][**0.2**][**0.1**] per second, minimum.

5. Filter Fabric, Woven: Geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:

a. Survivability: [**Class 1**][**Class 2**][**Class 3**].
b. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.25-mm)**][**No. 70 (0.212-mm)**][**No. 30 (0.6-mm)**] sieve, maximum.
c. Permittivity: [**0.5**][**0.2**][**0.1**][**0.02**] per second, minimum.

6. Film Backing: Polymeric film bonded to drainage core surface.

B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

a. [**Advanced Building Products Inc.**]
b. [**Low & Bonar PLC**]
c. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Advanced Building Products Inc.**]
b. [**Low & Bonar PLC**]
c. <**Insert manufacturer's name**>

3. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately **0.4 inches (10.2 mm)** thick.

a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**JDR Enterprises, Inc**]
b. [**Solmax International Inc.**]
c. [**Strata Systems, Inc**]
d. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**JDR Enterprises, Inc**]
b. [**Solmax International Inc.**]
c. [**Strata Systems, Inc**]
d. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately **0.25 inches (6 mm)** thick.

a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**][**5 gpm/ft. (62 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates

range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.

D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**Invisible Structures, Inc.**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Invisible Structures, Inc.**]
b. <**Insert manufacturer's name**>

3. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately **1 inch (25 mm)** thick.

a. Minimum In-Plane Flow Rate: [**40 gpm/ft. (500 L/min. per m)**]<**Insert value**> of unit width at hydraulic gradient of [**1.0**]<**Insert value**> and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

2.4 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earth Moving."

2.5 WATERPROOFING FELTS

A. Material: Comply with [**ASTM D226, Type I, asphalt**][**or**][**ASTM D227, coal-tar**]-saturated organic felt.

2.6 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from **110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m)** when tested in accordance with ASTM D4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO [**M 288 Class 2**]<**Insert class**>.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 INSTALLATION OF FOUNDATION DRAINAGE

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than **6 inches (150 mm)** deep and **12 inches (300 mm)** wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course, overlapping edges at least **4 inches (100 mm)**.

J. Install drainage panels on foundation walls as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
3. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.

K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Final backfill to finish elevations and

slope away from building.

3.4 INSTALLATION OF UNDERSLAB DRAINAGE

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least **6 inches (150 mm)** between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

H. Install horizontal drainage panels as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at inside edge of footing.
3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.5 INSTALLATION OF RETAINING-WALL DRAINAGE

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than **4 inches (100 mm)**.

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [**adhesive**][**or**][**tape**].

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.

E. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.

G. Place drainage course in layers not exceeding **3 inches (75 mm)** in loose depth; compact each layer

placed and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course, overlapping edges at least **4 inches (100 mm)**.

I. Install drainage panels on wall as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
3. If weep holes are used instead of drainage pipe, cut **1/2-inch- (13-mm-)** diameter holes on core side at weep-hole locations. Do not cut fabric.
4. Mark horizontal calk line on wall at a point **6 inches (150 mm)** less than panel width above footing bottom. Before marking wall, subtract footing width.
5. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from **2 to 6 inches (50 to 150 mm)** below top of panel, approximately **48 inches (1200 mm)** apart.[**Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails.**] Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
7. If another panel is required on same row, cut away **4 inches (100 mm)** of installed panel core and wrap fabric over new panel.
8. If additional rows of panel are required, overlap lower panel with **4 inches (100 mm)** of fabric.
9. Cut panel as necessary to keep top **12 inches (300 mm)** below finish grade.
10. For inside corners, bend panel. For outside corners, cut core to provide **3 inches (75 mm)** for overlap.

J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

3.6 INSTALLATION OF LANDSCAPING DRAINAGE

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.

D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least **6 inches (150 mm)** between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with [**adhesive**][**or**][**tape**].

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within **12 inches (300 mm)** of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course,

overlapping edges at least **4 inches (100 mm)**.

I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

3.7 INSTALLATION OF PIPING

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping level and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
2. Underslab Subdrainage: Install piping level.
3. Plaza Deck Subdrainage: Install piping level.
4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of [**0.5**]<**Insert value**> percent and with a minimum cover of [**36 inches (915 mm)**]<**Insert dimension**> unless otherwise indicated.
6. Lay perforated pipe with perforations down.
7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping in accordance with ASTM D2321.

3.8 CONSTRUCTION OF PIPE JOINTS

A. Join perforated PE pipe and fittings with couplings in accordance with ASTM D3212 with loose banded, coupled, or push-on joints.

B. Join perforated PVC sewer pipe and fittings in accordance with ASTM D3212 with loose bell-and-spigot, push-on joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 INSTALLATION OF BACKWATER VALVES

A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping[**in manholes or pits**] where indicated.

3.10 INSTALLATION OF CLEANOUTS

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for [**Foundation**][**Retaining-Wall**][**and**][**Landscaping**] Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**18 by 18 by 12 inches (450 by 450 by 300 mm)**]<**Insert dimensions**> deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use **NPS 4 (DN 100)** [**cast-iron**][**PVC**] pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**12 by 12 by 4 inches (300 by 300 by 100 mm)**]<**Insert dimensions**> deep. Set top of cleanout [**1 inch (25 mm)**][**2 inches (50 mm)**]<**Insert dimension**> above grade.
4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to[**building's**] solid-wall-piping storm drainage system.

C. Where required, connect low elevations of [**foundation**][**underslab**] subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."

1. Install PE warning tape or detectable warning tape over ferrous piping.
2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are

satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 31 05 13 00

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Task	Specification	Specification Description
31 05 13 00	31 20 00 00	Earth Moving
31 05 16 00	31 20 00 00	Earth Moving
31 05 16 00	31 05 13 00	Subdrainage

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SECTION 31 20 00 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil materials.
2. Geotextiles.
3. Controlled low-strength material.
4. Geofoam.
5. Accessories.

B. Related Requirements:

1. [**Section 013200 "Construction Progress Documentation"**][**Section 013233 "Photographic Documentation"**] for recording preexcavation and earth-moving progress.
2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping [**and stockpiling**] topsoil, and removal of above- and below-grade improvements and utilities.
3. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
4. Section 316329 "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.
5. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.2 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

B. Quantity allowances for earth moving are included in Section 012100 "Allowances."

C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

1. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
2. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
3. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
5. [**6 inches (150 mm)**]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
6. [**6 inches (150 mm)**]<**Insert dimension**> beneath pipe in trenches, and the greater of [**24 inches (600 mm)**]<**Insert dimension**> wider than pipe or [**42 inches (1065 mm)**]<**Insert dimension**> wide.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for in accordance with Contract provisions for [**unit prices**][**changes in the Work**] .
2. Bulk Excavation: Excavation more than [**10 ft. (3 m)**]<**Insert dimension**> in width and more than [**30 ft. (9 m)**]<**Insert dimension**> in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock:

1. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed [**1 cu. yd. (0.76 cu. m)**]<**Insert volume**> for bulk excavation or [**3/4 cu. yd. (0.57 cu. m)**]<**Insert volume**> for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

a. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a **42-inch- (1065-mm-)** maximum-width, short-tip-radius rock bucket; rated at not less than **138-hp (103-kW)** flywheel power with bucket-curling force of not less than **28,700 lbf (128 kN)** and stick-crowd force of not less than **18,400 lbf (82 kN)** with extra-long reach boom.
b. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than **230-hp (172-kW)** flywheel power and developing a minimum of **47,992-lbf (213.3-kN)** breakout force with a general-purpose bare bucket.

2. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material [**3/4 cu. yd. (0.57 cu. m)**]<**Insert volume**> or more in volume that exceed a standard penetration resistance of [**100 blows/2 inches (97 blows/50 mm)**]<**Insert value**> when tested by a geotechnical testing agency, in accordance with ASTM D1586/D1586M.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and

electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference [**at Project site**][**by web conference**]<**Insert location**> .

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of specified product.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: **12 by 12 inches (300 by 300 mm)**.
2. Warning Tape: **12 inches (300 mm)** long; of each color.

1.6 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each [**on-site**][**and**][**borrow**] soil material proposed for fill and backfill as follows:

1. Classification in accordance with ASTM D2487.
2. Laboratory compaction curve in accordance with [**ASTM D698**][**ASTM D1557**] .

B. Blasting plan [**approved by authorities having jurisdiction**] .

C. Seismic survey report from seismic survey agency.

D. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

E. Qualification Statements: For qualified testing agency.

1.7 QUALITY ASSURANCE

A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:

1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

C. Geotechnical Testing Agency Qualifications: Qualified in accordance with ASTM E329 and ASTM D3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify [**utility locator service**][**"Miss Utility"**][**"Call Before You Dig"**][**"Dig Safe System"**][**"One Call"**]<**Insert name**> for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in [**Section 015000 "Temporary Facilities and Controls"**][**and**][**Section 311000 "Site Clearing"**] are in place.

E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.

2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification [**Groups GW, GP, GM, SW, SP, and SM in accordance with ASTM D2487**][**Groups A-1, A-2-4, A-2-5, and A-3 in accordance with AASHTO M 145**] , or a combination of these groups; free of rock or gravel larger than [**3 inches (75 mm)**]<**Insert dimension**> in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: <**Insert value**> .
2. Plasticity Index: <**Insert value**> .

C. Unsatisfactory Soils: Soil Classification [**Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT in accordance with ASTM D2487**][**Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 in accordance with AASHTO M 145**] , or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 12 percent passing a **No. 200 (0.075-mm)** sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 8 percent passing a **No. 200 (0.075-mm)** sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch (37.5-mm)** sieve and not more than 12 percent passing a **No. 200 (0.075-mm)** sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a **1-inch (25-mm)** sieve and not more than 8 percent passing a **No. 200 (0.075-mm)** sieve.

H. Drainage Course: Narrowly graded mixture of [**washed**] crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a **1-1/2-inch (37.5-mm)** sieve and zero to 5 percent passing a **No. 8 (2.36-mm)** sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a **1-inch (25-mm)** sieve and zero to 5 percent passing a **No. 4 (4.75-mm)** sieve.

J. Sand: ASTM C33/C33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

a. Class 2; AASHTO M 288.
b. As follows:

1) Grab Tensile Strength: **157 lbf (700 N)**; ASTM D4632/D4632M.
2) Sewn Seam Strength: **142 lbf (630 N)**; ASTM D4632/D4632M.
3) Tear Strength: **56 lbf (250 N)**; ASTM D4533.
4) Puncture Strength: **56 lbf (250 N)**; ASTM D4833/D4833M.

c. Apparent Opening Size: [**No. 40 (0.425-mm)**][**No. 60 (0.250-mm)**][**No. 70 (0.212-mm)**] sieve, maximum; ASTM D4751.
d. Permittivity: [**0.5**][**0.2**][**0.1**] per second, minimum; ASTM D4491/D4491M.
e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

a. Class 2; AASHTO M 288.
b. As follows:

1) Grab Tensile Strength: **247 lbf (1100 N)**; ASTM D4632/D4632M.
2) Sewn Seam Strength: **222 lbf (990 N)**; ASTM D4632/D4632M.
3) Tear Strength: **90 lbf (400 N)**; ASTM D4533/D4533M.
4) Puncture Strength: **90 lbf (400 N)**; ASTM D4833/D4833M.

c. Apparent Opening Size: **No. 60 (0.250-mm)** sieve, maximum; ASTM D4751.
d. Permittivity: 0.02 per second, minimum; ASTM D4491/D4491M.
e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting [**, cellular, low-density**] , flowable concrete material produced from the following:

1. Portland Cement: ASTM C150/C150M, [**Type I**][**Type II**][**or**][**Type III**] .
2. Fly Ash: ASTM C618, Class C or F.
3. Normal-Weight Aggregate: ASTM C33/C33M, [**3/4-inch (19-mm)**][**3/8-inch (10-mm)**]<**Insert dimension**> nominal maximum aggregate size.
4. Foaming Agent: ASTM C869/C869M.
5. Water: ASTM C94/C94M.
6. Air-Entraining Admixture: ASTM C260/C260M.

B. Produce cellular, low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: [**30 to 36 lb/cu. ft. (480 to 576 kg/cu. m)**][**36 to 42 lb/cu. ft. (576 to 675 kg/cu. m)**]<**Insert unit weight range**> at point of placement, when tested in accordance with ASTM C138/C138M.
2. Compressive Strength: [**80 psi (550 kPa)**][**140 psi (965 kPa)**]<**Insert value**> , when tested in accordance with ASTM C495/C495M.

C. Produce conventional-weight, controlled low-strength material with [**80-psi (550-kPa)**][**140-psi (965-kPa)**]<**Insert value**> compressive strength when tested in accordance with ASTM C495/C495M.

2.4 GEOFOAM

A. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 1.55-lb/cu. ft. (25-kg/cu. m) density, 25-psi (173-kPa) compressive strength**][**Type X, 1.30-lb/cu. ft. (21-kg/cu. m) density, 15-psi (104-kPa) compressive strength**][**Type VI, 1.80-lb/cu. ft. (29-kg/cu. m) density, 40-psi (276-kPa) compressive strength**][**Type VII, 2.20-lb/cu. ft. (35-kg/cu. m) density, 60-psi (414-kPa) compressive strength**][**Type V, 3.00-lb/cu. ft. (48-kg/cu. m) density, 100-psi (690-kPa) compressive strength**] .

B. Molded-Polystyrene Board Insulation: ASTM C578, [**Type I, 0.90-lb/cu. ft. (15-kg/cu. m) density, 10-psi (69-kPa) compressive strength**][**Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) density, 13-psi (90-kPa) compressive strength**][**Type II, 1.35-lb/cu. ft. (22-kg/cu. m) density, 15-psi (104-kPa) compressive strength**] .

1. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.

C. Rigid Cellular Polystyrene Geofoam: ASTM D6817/D6817M, [**Type EPS 19, 1.15-lb/cu. ft. (18.4-kg/cu. m) density, 5.8-psi (40-kPa) compressive strength at 1 percent deformation; 16-psi (110-kPa) compressive strength at 10 percent deformation**][**Type EPS 39, 2.40-lb/cu. ft. (38.4-kg/cu. m) density, 15-psi (103-kPa) compressive strength at 1 percent deformation; 40-psi (276-kPa) compressive strength at 10 percent deformation**]<**Insert requirement**> .

D. Connectors: [**Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors**][**Deformed steel reinforcing bars, 3/4 inch (19 mm) in diameter**]<**Insert requirement**> .

2.5 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.

4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXPLOSIVES

A. Explosives:

1. Do not use explosives.
2. Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

    a. Perform blasting without damaging adjacent structures, property, or site improvements.
    b. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
    b. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
    c. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. [**6 inches (150 mm)**]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
    f. [**6 inches (150 mm)**]<**Insert dimension**> beneath pipe in trenches and the greater of [**24 inches (600 mm)**]<**Insert dimension**> wider than pipe or [**42 inches (1065 mm)**]<**Insert dimension**> wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation in accordance with unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. [**24 inches (600 mm)**]<**Insert dimension**> outside of concrete forms other than at footings.
    b. [**12 inches (300 mm)**]<**Insert dimension**> outside of concrete forms at footings.
    c. [**6 inches (150 mm)**]<**Insert dimension**> outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.

e. [6 inches (150 mm)]<**Insert dimension**> beneath bottom of concrete slabs-on-grade.
f. [6 inches (150 mm)]<**Insert dimension**> beneath pipe in trenches and the greater of [24 inches (600 mm)]<**Insert dimension**> wider than pipe or [42 inches (1065 mm)]<**Insert dimension**> wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots in accordance with requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: [12 inches (300 mm) **each side of pipe or conduit**][**As indicated**] .

C. Trench Bottoms:

1. Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints,

fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

a. For pipes and conduit less than **6 inches (150 mm)** in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
b. For pipes and conduit **6 inches (150 mm)** or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
c. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
d. Excavate trenches **6 inches (150 mm)** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

2. Excavate trenches **4 inches (100 mm)** deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

a. Excavate trenches **6 inches (150 mm)** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots in accordance with requirements in Section 015639 "Temporary Tree and Plant Protection."

3.8 EXCAVATION FOR ELEVATOR CYLINDER

A. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in [**Section 142400 "Hydraulic Elevators."**][**Section 142413 "Hydraulic Freight Elevators."**]

B. Provide well casing as necessary to retain walls of well hole.

3.9 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade [**below the building slabs and pavements**]<**Insert locations**> with a pneumatic-tired [**and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes)**]<**Insert requirement**> to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction [**, repeating proof-rolling in direction perpendicular to first direction**] . Limit vehicle speed to **3 mph (5 km/h)**.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for in accordance with Contract provisions for [**unit prices**][**changes in the Work**] .

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.10 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of **2500 psi (17.2 MPa)**, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.13 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within [**18 inches (450 mm)**]<**Insert dimension**> of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide [**4-inch- (100-mm-)**]<**Insert dimension**> thick, concrete-base slab

support for piping or conduit less than [30 inches (750 mm)]<**Insert dimension**> below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of [4 inches (100 mm)]<**Insert dimension**> of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of [**subbase material**][**satisfactory soil**] , free of particles larger than [1 inch (25 mm)]<**Insert dimension**> in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.

    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.14 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.15 GEOFOAM FILL

A. Place a leveling course of sand, [2 inches (50 mm)]<**Insert dimension**> thick, over subgrade. Finish leveling course to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

1. Place leveling course on subgrades free of mud, frost, snow, or ice.

B. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.

C. Install geofoam connectors at each layer of geofoam to resist horizontal displacement in accordance with geofoam manufacturer's written instructions.

D. Cover geofoam with [**subdrainage**][**separation**] geotextile before placing overlying soil materials.

3.16 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.17 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than [**8 inches (200 mm)**]<**Insert dimension**> in loose depth for material compacted by heavy compaction equipment and not more than **4 inches (100 mm)** in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] :

1. Under structures, building slabs, steps, and pavements, scarify and recompact top **12 inches (300 mm)** of existing subgrade and each layer of backfill or fill soil material at [**95**]<**Insert number**> percent.
2. Under walkways, scarify and recompact top **6 inches (150 mm)** below subgrade and compact each layer of backfill or fill soil material at [**92**]<**Insert number**> percent.
3. Under turf or unpaved areas, scarify and recompact top **6 inches (150 mm)** below subgrade and compact each layer of backfill or fill soil material at [**85**]<**Insert number**> percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at [**85**]<**Insert number**> percent.

3.18 GRADING

A. Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus [**1 inch (25 mm)**]<**Insert dimension**> .
2. Walks: Plus or minus [**1 inch (25 mm)**]<**Insert dimension**> .
3. Pavements: Plus or minus [**1/2 inch (13 mm)**]<**Insert dimension**> .

C. Grading inside Building Lines: Finish subgrade to a tolerance of [1/2 inch (13 mm)]<**Insert dimension**> when tested with a 10-foot (3-m) straightedge.

3.19 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer [**to 85 percent of maximum dry unit weight in accordance with ASTM D698**][**with a minimum of two passes of a plate-type vibratory compactor**] .

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer [**to 85 percent of maximum dry unit weight in accordance with ASTM D698**][**with a minimum of two passes of a plate-type vibratory compactor**] .
2. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.

3.20 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course [**and base course**] on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course [**and base course**] under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade in accordance with manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course [**and base course**] to required crown elevations and cross-slope grades.
4. Place subbase course [**and base course**] 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course [**and base course**] that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
6. Compact subbase course [**and base course**] at optimum moisture content to required grades, lines, cross sections, and thickness to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] .

C. Pavement Shoulders: Place shoulders along edges of subbase course [**and base course**] to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase [**and base**] layer to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with [**ASTM D698**][**ASTM D1557**] .

3.21 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade in accordance with manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course **6 inches (150 mm)** or less in compacted thickness in a single layer.
3. Place drainage course that exceeds **6 inches (150 mm)** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches (150 mm)** thick or less than **3 inches (75 mm)** thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than [**95**]<**Insert number**> percent of maximum dry unit weight in accordance with ASTM D698.

3.22 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Compaction Testing: Testing agency will test compaction of soils in place in accordance with ASTM D1556/D15556M, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every [**2000 sq. ft. (186 sq. m)**]<**Insert area**> or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every [**100 ft. (30 m)**]<**Insert dimension**> or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every [**150 ft. (46 m)**]<**Insert dimension**> or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.23 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.24 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

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Task	Specification	Specification Description
31 22 00 00	31 20 00 00	Earth Moving
31 22 13 00	31 20 00 00	Earth Moving
31 22 16 00	31 20 00 00	Earth Moving
31 22 16 13	31 20 00 00	Earth Moving
31 22 19 00	31 20 00 00	Earth Moving
31 22 19 13	31 20 00 00	Earth Moving
31 23 00 00	31 20 00 00	Earth Moving
31 23 16 00	31 20 00 00	Earth Moving

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SECTION 31 23 16 13 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 312000 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

C. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Land surveyor.
2. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the [**jurisdiction**][**state**] in which Project is located.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using [**photographs**][**or**][**video recordings**], show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify [**Architect**][**Construction Manager**][**Owner**] no fewer than [**two**]<**Insert number**> days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without [**Architect's**][**Construction Manager's**][**Owner's**] written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:

1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
2. Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
3. Compliance with requirements of authorities having jurisdiction.

4. Compliance with utility company requirements.
5. Compliance with railroad requirements.

2.2 MATERIALS

A. Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.

C. Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.

1. Corners: [**Site-fabricated mechanical interlock**][**Roll-formed corner shape with continuous interlock**].

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of [**size and strength required for application**][**3 inches (75 mm)**][**4 inches (100 mm)**]<**Insert dimension**>.

E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.

H. Tiebacks: Steel bars, ASTM A722/A722M.

I. Tiebacks: Steel strand, ASTM A416/A416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.3 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation.

1. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
2. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
3. Accurately align exposed faces of flanges to vary not more than [**2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment**]<**Insert tolerances**>.

B. Install wood lagging within flanges of soldier piles as excavation proceeds.

1. Trim excavation as required to install lagging.
2. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.4 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.

1. Limit vertical offset of adjacent sheet piling to **60 inches (1500 mm)**.
2. Accurately align exposed faces of sheet piling to vary not more than [**2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment**]<**Insert tolerances**>.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.5 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.8 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**][**daily**][**weekly**]<**Insert time period**> during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.9 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
2. Remove excavation support and protection systems to a minimum depth of [**48 (1200)**]<**Insert dimension**> **inches (mm)** below overlying construction, and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

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Task	Specification	Specification Description
31 23 16 13	31 20 00 00	Earth Moving

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SECTION 31 23 16 16 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain-link fence framework.
2. Chain-link fence fabric.
3. Chain-link fittings.
4. Chain-link wires and ties.
5. Chain-link swing gates.
6. Chain-link horizontal-slide gates.
7. Gate operators and controls.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete for post footings[**and equipment bases/pads for gate operators and controls**].
2. Section 281500 "Integrated Access Control Hardware Devices" for gate controls.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Inspect and discuss [**electrical roughing-in,**] equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of gate operator.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.
5. <**Insert requirement**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
b. Fence [**and gate**] posts, rails, and fittings.
c. Chain-link fabric, reinforcements, [**gate types, hardware,**] and attachments.
d. Accessories: [**Privacy slats**][**Barbed wire**][**Barbed tape**]<**Insert item**>.
e. Gates and hardware.
f. Gate operators, including operating instructions and motor characteristics.

B. Shop Drawings: For each type of fence [**and gate**] assembly.

1. Include plans, elevations, sections, ground details, [**mounting,**] post spacing, and attachments to

other work.
2. Include accessories, hardware, gate operation, and operational clearances.
3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1. Polymer-Coated Components: In **6-inch (150-mm)** lengths for components and on full-sized units for accessories.

E. Delegated Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**professional engineer**][**testing agency**][**factory-authorized service representative**].

B. Product Certificates: For each type of chain-link fence,[**operator,**] and gate.

C. Product Test Reports: For framework strength in accordance with ASTM F1043, for tests performed by [**manufacturer and witnessed by a qualified testing agency**][**or**][**a qualified testing agency**].

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: In accordance with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

C. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup for typical chain-link fence[**and gate**], including accessories.

a. Size: [10 ft. (3 m)]<**Insert dimension**> length of fence.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: [**Manufacturer agrees**][**Installer agrees**] to repair or replace components of fences[**, gates, operators, and controls**] that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gate operators and controls.
d. <**Insert failure modes**>.

2. Warranty Period: [**Five**][**15**]<**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks are to withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated in accordance with [**ASCE/SEI 7**]<**Insert requirement**>.

1. Design Wind Load: [**As indicated on Drawings**]<**Insert loads**>.

a. Minimum Post Size: Determine in accordance with ASTM F1043 for post spacing not to exceed [10 feet (3 m)]<**Insert dimension**> for Material [**Group IA, ASTM F1043, Schedule 40 steel pipe**][**Group IC, electric-resistance-welded round steel pipe**]<**Insert material group**>.
b. Minimum Post Size and Maximum Spacing: Determine in accordance with CLFMI WLG 2445, based on mesh size and pattern specified.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

D. Accessibility: Pedestrian gates to comply with the United States Access Board's ADA-ABA Accessibility Guidelines.

2.2 CHAIN-LINK FENCES, GENERAL

A. CLFMI Publications: Comply with the CLFMI Product Manual unless modified by requirements in the

Contract Documents.

B. Chain-Link Fence and Gate Assemblies: Include materials applicable for a complete assembly of application types, consisting of commercial, industrial, and security chain-link fences and gates.

1. Source Limitations: Obtain chain-link fence and gate components from single source or manufacturer.

2.3 CHAIN-LINK FENCE FRAMEWORK

A. Posts and Rails <**Insert drawing designation**>: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thicknesses in accordance with ASTM F1043[**or ASTM F1083**] based on the following:

1. Fence Height: [**72 inches (1830 mm)**][**96 inches (2440 mm)**][**As indicated on Drawings**]<**Insert dimension**>.
2. Light-Industrial-Strength Material: [**Group IC-L, round steel pipe, electric-resistance-welded pipe**][**Group II-L, roll-formed-steel C-section shapes**][**Group III-L, hot-rolled H-beam shapes**][**Group IV, Alternative Design**].

    a. Line Post: [**1.9 inches (48 mm) in diameter**][**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**2.25 by 1.7 inches (57 by 43 mm)**]<**Insert dimension(s)**>.
    b. End, Corner, and Pull Posts: [**2.375 inches (60 mm)**][**2.875 inches (73 mm)**][**4.0 inches (102 mm)**][**2.25 by 1.7 inches (57 by 43 mm)**]<**Insert dimension(s)**>.

3. Heavy-Industrial-Strength Material: [**Group IA, round steel pipe, Schedule 40**][**Group IC, round steel pipe, electric-resistance-welded pipe**][**Group II, roll-formed-steel C-section shapes**][**Group III, hot-rolled H-beam shapes**][**Group IV, Alternative Design**].

    a. Line Post: [**1.9 inches (48 mm) in diameter**][**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**4.0 inches (102 mm) in diameter**][**6.625 inches (168 mm) in diameter**][**1.875 by 1.63 inches (48 by 41 mm)**][**2.25 by 1.70 inches (57 by 43 mm)**][**3.25 by 2.50 inches (83 by 64 mm)**]<**Insert dimension(s)**>.
    b. End, Corner, and Pull Posts: [**2.375 inches (60 mm) in diameter**][**2.875 inches (73 mm) in diameter**][**4.0 inches (102 mm) in diameter**][**6.625 inches (168 mm) in diameter**][**2.25 by 1.70 inches (57 by 43 mm)**][**3.25 by 2.50 inches (83 by 64 mm)**]<**Insert dimension(s)**>.

4. Horizontal Framework Members: [**Intermediate**][**top**][**and**][**bottom**] rails in accordance with ASTM F1043.

    a. Top Rail: [**1.66 inches (42 mm) in diameter**][**1.25 by 1.63 inches (32 by 41 mm)**]<**Insert dimension(s)**>.

5. Brace Rails: ASTM F1043.
6. Metallic Coating for Steel Framework:

    a. Type A: Not less than minimum **2.0 oz./sq. ft. (0.61 kg/sq. m)** average zinc coating in accordance with ASTM A123/A123M or **4.0 oz./sq. ft. (1.22 kg/sq. m)** zinc coating in accordance with ASTM A653/A653M.
    b. Type B: Zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq. ft. (0.27 kg/sq. m)** of zinc after welding, a chromate conversion coating, and a clear, verifiable

polymer film.

c. External, Type B: Zinc with organic overcoat, consisting of a minimum of **0.9 oz./sq. ft. (0.27 kg/sq. m)** of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than **0.3-mil- (0.0076-mm-)** thick, zinc-pigmented coating.

d. Type C: Zn-5-Al-MM alloy, consisting of not less than **1.8 oz./sq. ft. (0.55 kg/sq. m)** coating.

e. Coatings: Any coating above.

7. Polymer coating over metallic coating.

a. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

2.4 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist in accordance with "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: <**Insert dimension**>[**As indicated on Drawings**].
2. Steel Wire for Fabric: Wire diameter of [**0.192 inch (4.88 mm)**][**0.148 inch (3.76 mm)**][**0.120 inch (3.05 mm)**][**0.113 inch (2.87 mm)**]<**Insert dimension**>.

a. Mesh Size: [**2-1/8 inches (54 mm)**][**2 inches (50 mm)**][**1-3/4 inches (44 mm)**][**1 inch (25 mm)**]<**Insert dimension**>.

b. Aluminum-Coated Fabric: ASTM A491, Type I, [**0.40 oz./sq. ft. (122 g/sq. m)**][**0.35 oz./sq. ft. (107 g/sq. m)**][**0.30 oz./sq. ft. (92 g/sq. m)**].

c. Zinc-Coated Fabric: ASTM A392, Type II, [**Class 1, 1.2 oz./sq. ft. (366 g/sq. m)**][**Class 2, 2.0 oz./sq. ft. (610 g/sq. m)**] with zinc coating applied [**before**][**after**] weaving.

d. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F1345, Type III, [**Class 1, 0.60 oz./sq. ft. (183 g/sq. m)**][**Class 2, 1.0 oz./sq. ft. (305 g/sq. m)**].

e. Polymer-Coated Fabric: ASTM F668, [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

1) Color: [**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

f. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Aluminum Wire Fabric: ASTM F1183, with [**mill**][**caustic-cleaned or etched**] finish, and wire diameter of [**0.148 inch (3.76 mm)**][**0.192 inch (4.88 mm)**].

a. Mesh Size: [**2 inches (50 mm)**][**1 inch (25 mm)**].

4. Selvage: [**Knuckled at both selvages**][**Twisted top and knuckled bottom**].

2.5 CHAIN-LINK FITTINGS

A. Provide fittings in accordance with ASTM F626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: [**Pressed-steel or round-steel tubing**][**Aluminum Alloy 6063**] not less than **6 inches (152 mm)** long.
2. Rail Clamps: Line and corner boulevard clamps for connecting [**intermediate**][**and**][**bottom**] rails to posts.

E. Tension and Brace Bands: [**Pressed steel**][**Aluminum Alloy 6063**].

F. Tension Bars: [**Steel**][**Aluminum**][**Fiberglass**], length not less than **2 inches (50 mm)** shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: [**Steel, hot-dip galvanized after threading**][**Mill-finished aluminum**] rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: [**Pressed steel or cast iron**][**Aluminum**], with clips, slots, or other means for attaching strands of barbed wire[**, and means for attaching to posts**][**, integral with post cap**], for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: [**Type I, slanted arm**][**Type II, vertical arm**].
4. Double-Arm Type: [**Type III, V-shaped arm**][**Type IV, A-shaped arm**].

I. Tie Wires, Clips, and Fasteners: In accordance with ASTM F626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, in accordance with the following:

a. Hot-Dip Galvanized Steel: [**0.106-inch- (2.69-mm-)**][**0.148-inch- (3.76-mm-)**] diameter wire[**; galvanized coating thickness matching coating thickness of chain-link fence fabric**].
b. Aluminum: ASTM B211/B211M; Alloy 1350-H19; [**0.148-inch- (3.76-mm-)**][**0.192-inch- (4.88-mm-)**] diameter, mill-finished wire.

J. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than **1.2 oz./sq. ft. (366 g/sq. m)** of zinc.

a. Polymer coating over metallic coating.

2. Aluminum: Mill finish.

2.6 CHAIN-LINK WIRE AND TIES

A. Metallic-Coated Steel Wire: **0.177-inch- (4.5-mm-)** diameter, marcelled tension wire in accordance with ASTM A817 or ASTM A824, with the following metallic coating:

1. Type I: Aluminum coated (aluminized).
2. Type II: Zinc coated (galvanized) by [**hot-dip**][**electrolytic**] process, with the following minimum coating weight:

    a. Class 3: Not less than **0.8 oz./sq. ft. (244 g/sq. m)** of uncoated wire surface.
    b. Class 4: Not less than **1.2 oz./sq. ft. (366 g/sq. m)** of uncoated wire surface.
    c. Class 5: Not less than **2 oz./sq. ft. (610 g/sq. m)** of uncoated wire surface.
    d. Matching chain-link fabric coating weight.

3. Type III: Zn-5-Al-MM alloy with the following minimum coating weight:

    a. Class 60: Not less than **0.6 oz./sq. ft. (183 g/sq. m)** of uncoated wire surface.
    b. Class 100: Not less than **1 oz./sq. ft. (305 g/sq. m)** of uncoated wire surface.
    c. Matching chain-link fabric coating weight.

B. Polymer-Coated Steel Wire: [**0.177-inch- (4.5-mm-)**][**0.148-inch- (3.8-mm-)**] diameter, tension wire in accordance with ASTM F1664, [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

1. Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**], in accordance with ASTM F934.

C. Aluminum Wire: **0.192-inch- (4.88-mm-)** diameter tension wire, mill finished, in accordance with **ASTM B211 (ASTM B211M)**, Alloy 6061-T94 with **50,000-psi (344-MPa)** minimum tensile strength.

2.7 CHAIN-LINK SWING GATES

A. General: ASTM F900 for gate posts and [**single**][**double**] swing gate types.[**Provide automated vehicular gates in accordance with ASTM F2200.**]

1. Gate Leaf Width: [**36 inches (914 mm)**][**As indicated**]<**Insert width**>.
2. Framework Member Sizes and Strength: Based on gate fabric height [**of 72 inches (1830 mm) or less**][**of more than 72 inches (1830 mm)**][**as indicated**]<**Insert dimension**>.

B. Swing Gate Pipe and Tubing:

1. Swing Gate Posts: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].
2. Gate Frames and Bracing: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].
3. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; [**protective coating and finish to match fence framework**][**manufacturer's standard protective coating and finish**]<**Insert finish**>.
4. Aluminum: ASTM B429/B429M; [**mill**][**manufacturer's standard**]<**Insert finish**> finish.

C. Swing Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**].

D. Swing Gate Extended Posts and Frame Members: Fabricate gate posts and frame end members to extend [**12 inches (300 mm)**][**as indicated**]<**Insert dimension**> above top of chain-link fabric at both ends of gate frame to attach barbed [**wire**][**tape**] assemblies.

E. Swing Gate Hardware:

1. Hinges: [**180-degree inward**][**180-degree outward**][**360-degree inward and outward**] swing.
2. Latch: Permitting operation from both sides of gate[**with provision for padlocking accessible from both sides of gate**].

3. Lock: [**Manufacturer's standard**]<**Insert requirement**> internal device.
4. Padlock and Chain: <**Insert requirements**>.
5. Closer: [**Manufacturer's standard**]<**Insert requirement**>.
6. <**Insert hardware items and accessories**>.

2.8 CHAIN-LINK HORIZONTAL-SLIDE GATES

A. Chain-Link Horizontal-Slide Gates: ASTM F1184 for gate posts and [**single**][**double**] sliding gate types for [**pedestrian**][**and**][**vehicle**] assembly.[**Provide automated vehicular gates in accordance with ASTM F2200.**]

1. Classification:

a. Type I Overhead Slide:

1) Gate Leaf Width: [**As indicated**]<**Insert width**>.
2) Framework Member Sizes and Strength: Based on gate fabric height [**of 72 inches (1830 mm) or less**][**of more than 72 inches (1830 mm)**][**as indicated**]<**Insert dimension**>.

b. Type II Cantilever Slide, [**Class 1 with external**][**Class 2 with internal**] roller assemblies:

1) Slide Gate Frame Width and Height: [**48 inches (1220 mm) wide or less by 72 inches (1830 mm) high or less**][**More than 48 inches (1220 mm) wide by any height**][**As indicated**]<**Insert dimension**>.

B. Slide Gate Pipe and Tubing Finish:

1. Zinc-Coated Steel: [**Protective coating and finish to match fence framework**][**Manufacturer's standard protective coating and finish**]<**Insert finish**>.
2. Aluminum: ASTM B429/B429M; [**mill**][**manufacturer's standard**]<**Insert finish**> finish.
3. Sliding Gate Posts: ASTM F1184. Provide [**round tubular steel**][**rectangular tubular steel**][**round tubular aluminum**][**rectangular tubular aluminum**] posts.
4. Sliding Gate Frames and Bracing: [**Round tubular steel**][**Rectangular tubular steel**][**Round tubular aluminum**][**Rectangular tubular aluminum**].

C. Slide Gate Frame Corner Construction: [**Welded**][**or**][**assembled with corner fittings**].

D. Slide Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame [**12 inches (300 mm)**][**as indicated**]<**Insert dimension**> as required to attach barbed [**wire**][**tape**] assemblies.

E. Overhead Track Assembly: Manufacturer's standard track, with overhead framework supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

F. Slide Gate Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from [**galvanized steel**][**galvanized malleable iron**][**mill-finished Grade 319 aluminum-alloy casting with stainless steel fasteners**].
2. Latch: Permitting operation from both sides of gate[**with provision for padlocking accessible from both sides of gate**].
3. Lock: [**Manufacturer's standard**]<**Insert requirement**> internal device.

4. Padlock and Chain: <**Insert requirements**>.
5. <**Insert hardware items and accessories**>.

2.9 ACCESSORIES

A. Privacy Slats:

1. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than **0.06 inch (1.5 mm)** thick, sized to fit mesh specified for direction indicated[**, with vandal-resistant fasteners and lock strips**].
2. Tubular Polyethylene Slats: Minimum **0.023-inch (0.58-mm)**-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with [**vandal-resistant fasteners and lock strips**][**fins for increased privacy factor**].
3. Aluminum Slats: Minimum **0.01-inch (0.25-mm)**-thick aluminum, sized to fit mesh specified for direction indicated.
4. Redwood Slats: **5/16-inch (7.9-mm)**-thick redwood, sized to fit mesh specified for direction indicated.
5. Hedge-Type Slats: UV-light-stabilized[**, flame-resistant**], PVC "needles" woven into braided, galvanized wire core, sized to fit mesh specified for direction indicated.
6. Color: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**][**As indicated on Drawings**]<**Insert color**>.

B. Barbed Wire:

1. Steel Barbed Wire: ASTM A121, two-strand barbed wire, **0.099-inch- (2.51-mm-)** diameter line wire with **0.080-inch- (2.03-mm-)** diameter, four-point round barbs spaced not more than **5 inches (127 mm)** o.c.

    a. Aluminum Coating: Type A.
    b. Zinc Coating: Type Z, Class 3.

2. Polymer-Coated, Galvanized-Steel Barbed Wire: ASTM F1665, two-strand barbed wire, **0.080-inch- (2.03-mm-)** diameter line wire with **0.080-inch- (2.03-mm-)** diameter, four-point, round [**aluminum alloy**][**galvanized-steel**] barbs spaced not more than **5 inches (127 mm)** o.c.

    a. Polymer Coating: [**Class 1**][**Class 2a**][**Class 2b**] over [**aluminum**][**zinc**][**Zn-5-Al-MM-alloy**]-coated steel wire.

        1) Color: [**Match chain-link fabric**][**Dark green**][**Olive green**][**Brown**][**Black**][**As selected by Architect from manufacturer's full range**] in accordance with ASTM F934.

3. Barbed Tape:

    a. Wire-Reinforced Tape: ASTM F1910; continuous coils with four-point, needle-sharp barbs permanently cold clenched around a core wire.
    b. Core Wire: High-tensile-strength, [**zinc-coated steel**][**or**][**stainless steel**].
    c. Configuration: [**Single**][**Double**] coil.
    d. Style: [**Helical**][**Concertina**] pattern.
    e. Coil Diameter(s): [**18-inch (457-mm)**][**24 inches (610 mm)**][**24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil**][**As indicated on Drawings**]<**Insert diameter**>.
    f. Coil Loop Spacing(s): [**12 inches (300 mm)**][**Manufacturer's standard**][**As indicated on Drawings**]<**Insert spacing**>.

g. Barb Length Classification: [**Long, 1.2-inch (30.5-mm)**][**Medium, 0.4-inch (10.2-mm)**][**Short, 0.1875-inch (4.76-mm)**] barb.
h. Barb Spacing: [**4 inches (102 mm)**]<**Insert dimension**> o.c.
i. Barb Set: [**Straight**][**Offset**][**Manufacturer's standard**].

4. Clips: Stainless steel, **0.065 inch (1.7 mm)** thick by **0.375 inch (9.5 mm)** wide, capable of withstanding a minimum **150-lbf (667-N)** pull load to limit extension of coil, resulting in a concertina pattern when deployed.
5. Tie Wires: Stainless steel, **0.065 inch (1.7 mm)** in diameter.

C. Touch-up Paint: Liquid polymer for field coating with polymer coated fencing components as recommended by manufacturer.

2.10 GATE OPERATORS AND CONTROLS

A. Provide factory-assembled automatic operating system designed for [**pedestrian**][**and**][**vehicle**] gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with [**remote-control stations**], safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide [**UL 325 listed operators for swing gates**][**BHMA A156.19 listed operators for pedestrian gates**][**ASTM F2200 for automated vehicular gates**].

B. Comply with NFPA 70.

C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.

D. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

1. Voltage: [**110 V**][**220 V**][**24 V dc**][**NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected**]<**Insert voltage**>.
2. Phase: [**One**][**Polyphase**].
3. Enclosure: [**Open dripproof**][**Totally enclosed**][**Manufacturer's standard**].
4. Duty: Continuous duty at ambient temperature of **105 deg F (40 deg C)** and at altitude of **3300 ft. (1005 m)** above sea level.
5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

E. Gate Operators: [**Gate**][**Concrete base**][**Post**][**In-ground**] mounted and as follows:

1. Hydraulic Gate Operators: [**Swing**][**Slide**].

a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
b. Gate Speed: Minimum [**45 feet (13.7 m)**][**60 feet (18.2 m)**] per minute.
c. Maximum Gate Weight: [**800 lb (363 kg)**]<**Insert value**>.
d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**Continuous duty**].
e. Hydraulic Fluid: Viscosity required for gate operation at ambient temperature range for Project.
f. Locking: Hydraulic in both directions.

2. Mechanical Gate Operators: [**Swing**][**Slide**].

    a. Duty: [**Light**][**Medium**][**Heavy**] duty, [**residential**][**commercial/industrial**].
    b. Gate Speed: Minimum [**45 feet (13.7 m) per minute**][**60 feet (18.2 m) per minute**][**variable speed**]<**Insert speed**>.
    c. Maximum Gate Weight: [**600 lb (272 kg)**][**800 lb (363 kg)**][**3000 lb (1360 kg)**]<**Insert value**>.
    d. Frequency of Use: [**10 cycles per hour**][**25 cycles per hour**][**60 cycles per hour**][**Continuous duty**].
    e. Operating Type: [**Crank arm**][**Wheel-and-rail drive**][**Roller chain**].
    f. <**Insert feature**>.

F. Activation Controls: Electric controls separated from gate and motor and drive mechanism, with [**NEMA ICS 6, Type 1**][**NEMA ICS 6, Type 4**]<**Insert type of enclosure**> enclosure for [**surface**][**recessed or flush**][**concrete base**][**pedestal**]<**Insert mounting**> mounting, and with space for additional optional equipment. Provide the following remote-control device(s):

1. Control Station:

    a. Keyed, [**two**][**three**]-position switch with open[**, stop,**] and close function; located remotely from gate. Provide two keys per station.
    b. Momentary-contact, [**single**][**three**]-button-operated with open[**, stop,**] and close function; located remotely from gate.[**Key switch to lock out open and close buttons.**]
    c. <**Insert other type**>.

2. Card Reader: Functions only when authorized card is presented. Programmable, [**multiple**][**single**]-code system[**, permitting four different access periods**][**; face-lighted unit fully visible at night**].

    a. Reader Type: [**Touch plate**][**Swipe**][**Insertion**][**Proximity**].
    b. Card Reader Features:

        1) Usage Features: [**Timed antipassback**][**Limited-time usage**][**Capable of monitoring and auditing gate activity**].

3. <**Insert other reader type and features**>.
4. Digital Keypad Entry Unit: [**Programmable,**]multiple-code capability of not less than [**five**][**500**][**2500**]<**Insert number**> possible individual codes, consisting of [**1- to 7**][**4**][**5**]-digit codes[**, and permitting four different access periods**].
5. Face-lighted unit with [**metal-keyed**][**keyless-membrane**] keypad fully visible at night.
6. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide [**one**][**two**]<**Insert number**> programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than [**1000**][**10,000**]<**Insert number**> codes per channel configured for the following functions:

    a. Transmitters: [**Single**][**Three**]-button operated, with open [**and close**]function.
    b. Channel Settings: [**Two**][**Three**][**Four**]<**Insert number**> independent channel settings controlling separate receivers for operating more than one gate from each transmitter.

7. Telephone Entry System: Hands-free, voice-communication system for connection to building telephone system with digital-entry code activation of gate operator[**and auxiliary keypad entry**].

    a. Residential System: Designed to be wired to same line with telephone.
    b. Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to

access [**20**][**100**]<**Insert number**> telephones[**, and with electronic directory**].
c. <**Insert other system type and features**>.
d. Intercom System: <**Insert requirements**>.

G. Vehicle Sensing System: System includes automatic closing timer with adjustable time delay[**, timer cutoff switch,**] and loop detector designed to [**open and close gate**][**hold gate open until traffic clears**][**reverse gate**]<**Insert functions**>. System includes electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. System includes number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement, as recommended in writing by detection system manufacturer for function indicated, at location indicated on Drawings.

H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: [**Reverse gate in both opening and closing cycles and hold until clear of obstruction**][**Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction**].
2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as recommended by manufacturer.
4. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

I. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.

1. Type: [**Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge**][**Mechanical device, key, or crank-activated release**].

J. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features[**with capability for monitoring and auditing gate activity**]. Provide unit that is isolated from voltage spikes and surges.
2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
3. Master/Slave Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing[**and timer cutoff switch**].
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
8. Clock Timer: [**24-hour**][**Seven-day**]<**Insert time**> programmable for regular events.

K. Accessories:

1. Warning Module: [**Audio**][**Visual**], [**constant**][**strobe**]-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the United States Access Board's ADA-ABA Accessibility Guidelines.
2. Battery Backup System: Battery-powered drive and access-control system, independent of

primary drive system.

a. Fail-Safe: Gate opens and remains open until power is restored.
b. Fail-Secure: Gate cycles on battery power, then fail-safe when battery is drained.

3. External electric-powered [**solenoid**][**magnetic**] lock with delay timer allowing time for lock to release before gate operates.
4. [**Fire**][**Postal**] box.
5. Fire [**strobe**][**siren**] sensor.
6. Instructional, Safety, and Warning Labels and Signs: [**In accordance with UL 325**][**Manufacturer's standard for components and features specified**][**As indicated on Drawings**]<**Insert requirements**>.
7. Equipment Bases/Pads: Precast concrete, [**depth not less than 12 inches (305 mm)**]<**Insert depth**>, dimensioned and reinforced in accordance with gate operator component manufacturer's written instructions and as indicated on Drawings.

2.11 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.12 CONCRETE

A. Concrete Post Footings: Minimum 28-day compressive strength of **2500 psi (17.2 MPa)**.

2.13 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, **5/8 by 96 inches (16 by 2440 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for[**a certified survey of property lines and legal boundaries,**] site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by

Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of **500 feet (152 m)** or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION OF CHAIN-LINK FENCES

A. Install chain-link fencing in accordance with ASTM F567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts [**in concrete**][**with mechanical anchors**][**by mechanically driving into soil**] at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend **2 inches (50 mm)** above grade; shape and smooth to shed water.
    b. Concealed Concrete: Place top of concrete [**2 inches (50 mm)**]<**Insert dimension**> below grade [**as indicated on Drawings**]to allow covering with surface material.
    c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed in accordance with anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
    d. Posts Set into Holes in Concrete: Form or core drill holes not less than **5 inches (127 mm)** deep and **3/4 inch (20 mm)** larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**][**or**][**anchoring cement**], mixed and placed in accordance with anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3. Mechanically Driven Posts: Drive into soil to depth of [**30 inches (762 mm)**][**36 inches (914 mm)**]<**Insert dimension**>. Protect post top to prevent distortion.

D. Terminal Posts: Install terminal end, corner, and gate posts in accordance with ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of [**15 degrees or more**][**30 degrees or more**][**as indicated on Drawings**]<**Insert requirement**>. For runs exceeding **500 feet (152 m)**, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at [**96 inches (2440 mm)**][**10 feet (3 m)**]<**Insert dimension**> o.c.

F. Post Bracing and Intermediate Rails: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric **72 inches (1830 mm)** or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with **0.120-inch- (3.05-mm-)** diameter hog rings of same material and finish as fabric wire, spaced a maximum of **24 inches (610 mm)** o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along [**top**][**and**][**bottom**] of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within **6 inches (152 mm)** of bottom of fabric and tie to each post with not less than same diameter and type of wire.
2. Extended along top of [**barbed wire arms**][**extended posts**] and top of fence fabric to support barbed tape.
3. [**As indicated on Drawings**]<**Insert requirements**>.

H. Top Rail: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to [**outside**][**inside**] of enclosing framework. Leave [**1-inch (25-mm)**][**2-inch (50-mm)**] bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than **15 inches (380 mm)** o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric in accordance with ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at **12 inches (300 mm)** o.c. and to braces at **24 inches (610 mm)** o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.[**Peen ends of bolts or score threads to prevent removal of nuts.**]

N. Privacy Slats: Install slats in direction indicated, securely locked in place.

1. [**Vertically**][**Horizontally**][**, for privacy factor of 70 to 75**]<**Insert privacy factor range**>.
2. Diagonally[**for privacy factor of 80 to 85**]<**Insert privacy factor range**>.
3. Direction[**and privacy factor**] as indicated on Drawings.

O. Barbed Wire: Install barbed wire uniformly spaced[**, angled toward security side of fence**][**as indicated on Drawings**]. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

P. Barbed Tape: Install in accordance with ASTM F1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

3.4 INSTALLATION OF GATES

A. Install gates in accordance with manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 INSTALLATION OF GATE OPERATORS

A. Install gate operators in accordance with manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations in accordance with gate-operator component manufacturer's written instructions and as indicated.

C. Vehicle Loop Detector System: [**Cut grooves in pavement, bury, and seal**][**Bury**] wire loop in accordance with manufacturer's written instructions. Connect to equipment operated by detector.

D. Ground electric-powered motors, controls, and other devices in accordance with NFPA 70 and manufacturer's written instructions.

3.6 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence and Gate Grounding:

1. Ground for fence and fence posts is to be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of [**1500 feet (450 m)**]<**Insert dimension**>.
3. Fences within 100 ft. (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of [**750 ft. (225 m)**]<**Insert dimension**>.
4. Ground fence on each side of gates and other fence openings.

    a. Bond metal gates to gate posts.
    b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least **18 inches (457 mm)** below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of **150 feet (45 m)** on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground in accordance with IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is **6 inches**

(152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

F. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor in accordance with NFPA 780.

H. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.

1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Test and adjust operators, controls**[, alarms,]** and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Lubricate operator and related components.

C. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 31 23 16 16

Task	Specification	Specification Description
31 23 16 16	31 20 00 00	Earth Moving
31 23 16 26	31 20 00 00	Earth Moving
31 23 16 33	31 20 00 00	Earth Moving
31 23 16 36	31 20 00 00	Earth Moving
31 23 16 36	31 23 16 13	Excavation Support and Protection
31 23 16 46	31 23 16 13	Excavation Support and Protection

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SECTION 31 23 19 00 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction dewatering.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Section 015723 "Temporary Storm Water Pollution Control" for temporary storm water pollution controls mandated under the EPA's National Pollutant Discharge Elimination System.
3. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1. Dewatering observation wells are part of [**dewatering**]<**Insert description**> allowance.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered, including coordination with temporary erosion-control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.

4. Include written plan for dewatering operations, including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

B. Delegated Design Submittals: For dewatering system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Submittals:

1. Field quality-control reports.

B. Qualification Statements: For [**Installer**][**and**][**land surveyor**]<**Insert entity or specialist**>.

C. Delegated design engineer qualifications.

D. Existing Conditions: Using [**photographs**][**or**][**video recordings**], show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

E. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installer: An experienced installer that has specialized in [**design of dewatering systems and**]dewatering work.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.
3. Land Surveyor: A professional land surveyor who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located.

1.7 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering in accordance with the performance requirements.
2. The geotechnical report is [**included**][**referenced**] elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design dewatering system.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in [**Section 015000 "Temporary Facilities and Controls,"**][**Section 015723 "Temporary Storm Water Pollution Control"**][**Section 311000 "Site Clearing,"**] during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below groundwater level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control groundwater to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of [**24 inches (600 mm)**][**60 inches (1500 mm)**]<**Insert dimension**> below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of **36 inches (900 mm)** below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of groundwater and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well

risers to demonstrate that observation wells are functioning properly.

3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**][**monthly**]<**Insert time period**> during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19 00

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Task	Specification	Specification Description
31 23 19 00	31 20 00 00	Earth Moving
31 23 23 00	31 20 00 00	Earth Moving
31 23 23 23	31 20 00 00	Earth Moving

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SECTION 31 25 14 23 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick pavers.
2. Concrete pavers.
3. Asphalt-block pavers.
4. Stone pavers.
5. Curbs and edge restraints.

B. Related Requirements:

1. [**Section 075113 "Built-up Asphalt Roofing"**][**Section 075116 "Built-up Coal Tar Roofing"**][**Section 075213 "Atactic-Polypropylene (APP) Modified Bituminous Membrane Roofing"**][**Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing"**][**Section 075316 "Chlorosulfonate-Polyethylene (CSPE) Roofing"**][**Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing"**][**Section 075416 "Ketone Ethylene Ester (KEE) Roofing"**][**Section 075419 "Polyvinyl-Chloride (PVC) Roofing"**][**Section 075423 "Thermoplastic Polyolefin (TPO) Roofing"**][**Section 075552.13 "Atactic-Polypropylene (APP) Modified Bituminous Protected Membrane Roofing"**][**Section 075552.16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Protected Membrane Roofing"**][**Section 075556 "Fluid-Applied Protected Membrane Roofing"**] for roof pavers.
2. Section 096313 "Brick Flooring" for brick flooring for interior applications.
3. Section 096340 "Stone Flooring" for dimension stone paving.
4. Section 321216 "Asphalt Paving" for asphalt base under unit pavers.
5. Section 321313 "Concrete Paving" [**for concrete base under unit pavers**][**and**][**for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers**].
6. Section 321443 "Porous Unit Paving" for unit paving using grid pavers or pavers with openings between them.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:

a. Pavers.
b. Bituminous setting materials.
c. Mortar and grout materials.
d. Edge restraints.
e. Precast concrete curbs.

f. Granite curbs.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

D. Samples for Initial Selection: For each type of unit paver indicated[**.**][**and the following:**]

1. Joint materials involving color selection.
2. Exposed edge restraints involving color selection.
3. Precast concrete curbs.
4. Granite curbs.

E. Samples for Verification: For full-size units of each type of unit paver indicated.[**Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints.**][**Include Samples of the following:**]

1. Joint materials.
2. Exposed edge restraints.
3. Precast concrete curbs.
4. Granite curbs.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

C. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified unit paving installer. Installer's [**field supervisor**][**personnel assigned to the Work**] must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with [**one of**][**both of**] the following designations:

1. Residential Paver Technician Designation.
2. Commercial Paver Technician Designation.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.8 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above **40 deg F (4 deg C)** and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above **50 deg F (10 deg C)** and when temperature has not been below **35 deg F (2 deg C)** for 12 hours immediately before application.

Do not apply when setting bed is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of **100 deg F (38 deg C)** and higher.

a. When ambient temperature exceeds **100 deg F (38 deg C)**, or when wind velocity exceeds **8 mph (13 km/h)** and ambient temperature exceeds **90 deg F (32 deg C)**, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 BRICK PAVERS

A. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Brick shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Brick shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Brick Pavers, Light-Traffic Paving Brick: ASTM C902, Class SX[**or Class MX**], [**Type I**][**Type II**][**Type III**], Application [**PS**][**PX**][**PA**]. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Thickness: [**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-5/8 inches (41 mm)**][**2-1/4 inches (57 mm)**][**2-5/8 inches (67 mm)**][**As indicated**]<**Insert dimension**>.
2. Face Size: [**3-3/4 by 7-1/2 inches (95 by 190 mm)**][**3-5/8 by 7-5/8 inches (92 by 194 mm)**][**3-5/8**

by 11-5/8 inches (92 by 295 mm)][7-5/8 by 7-5/8 inches (194 by 194 mm)][4 by 8 inches (102 by 203 mm)][4 by 12 inches (102 by 305 mm)][8 by 8 inches (203 by 203 mm)][As indicated]<Insert dimensions>.

3. Color: [**Dark red**][**Medium red**][**Full-range red**][**Dark brown**][**Medium brown**][**Full-range brown**][**Tan**][**Buff**][**Cream**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

G. Brick Pavers, Heavy Vehicular Paving Brick: ASTM C1272, [**Type F, Application PX**][**Type R, Application PS**][**Type R, Application PX**][**Type R, Application PA**]. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Thickness: [**2-1/4 inches (57 mm)**][**2-5/8 inches (67 mm)**][**As indicated**]<**Insert dimension**>.
2. Face Size: [**3-3/4 by 7-1/2 inches (95 by 190 mm)**][**3-5/8 by 7-5/8 inches (92 by 194 mm)**][**3-5/8 by 11-5/8 inches (92 by 295 mm)**][**7-5/8 by 7-5/8 inches (194 by 194 mm)**][**4 by 8 inches (102 by 203 mm)**][**4 by 12 inches (102 by 305 mm)**][**8 by 8 inches (203 by 203 mm)**][**As indicated**]<**Insert dimensions**>.
3. Color: [**Dark red**][**Medium red**][**Full-range red**][**Dark brown**][**Medium brown**][**Full-range brown**][**Tan**][**Buff**][**Cream**][**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

H. Efflorescence: Brick to be rated "not effloresced" when tested according to ASTM C67.

I. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

2.3 CONCRETE PAVERS

A. Regional Materials: Concrete pavers shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Concrete pavers shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Concrete pavers shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Concrete pavers shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Concrete pavers shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Concrete Pavers, Solid Interlocking Paving Units: Complying with ASTM C936/C936M[**and resistant to freezing and thawing when tested according to ASTM C67**], made from normal-weight aggregates.

1. Thickness: [2-3/8 inches (60 mm)][3-1/8 inches (80 mm)]<Insert dimension>.
2. Face Size and Shape:

    a. [3-7/8 inches (98 mm)][4-7/16 inches (113 mm)][8-7/8 inches (225 mm)][9 inches (229 mm)] square.
    b. [3-7/8-by-7-7/8-inch (98-by-200-mm)][4-by-8-inch (102-by-203-mm)][4-7/16-by-8-7/8-inch (113-by-225-mm)] rectangle.
    c. [5-1/2-inch (140-mm) octagon with attached 3-1/2-inch (89-mm) square][4-1/2-by-9-inch (114-by-229-mm) rectangle with saw-tooth edges][4-3/4-inch (121-mm) rectangular and trapezoidal units arranged in semicircular courses to produce fan-shaped pattern][As indicated]<Insert dimensions and shape>.

3. Color: [As indicated by manufacturer's designations][Match Architect's sample][As selected by Architect from manufacturer's full range]<Insert color>.

G. Concrete Pavers, Solid Paving Units, Normal-Weight Concrete: Solid paving units made from normal-weight concrete with a compressive strength not less than [5000 psi (34 MPa)][6000 psi (41 MPa)]<Insert value>, water absorption not more than 5 percent according to ASTM C140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67.

1. Thickness: [1-5/8 inches (41 mm)][1-3/4 inches (45 mm)][2 inches (51 mm)][2-3/8 inches (60 mm)]<Insert dimension>.
2. Face Size and Shape:

    a. [8-7/8 inches (225 mm)][9 inches (229 mm)][12 inches (305 mm)][18 inches (457 mm)][24 inches (610 mm)] square.
    b. [9-by-18-inch (229-by-457-mm)][12-by-24-inch (305-by-610-mm)] rectangle.
    c. [As indicated]<Insert dimensions and shape>.

3. Color: [As indicated by manufacturer's designations][Match Architect's sample][As selected by Architect from manufacturer's full range]<Insert color>.

H. Concrete Pavers, Solid Paving Units, Lightweight Concrete: Solid paving units complying with ASTM C1491, made from lightweight concrete.

1. Thickness: [1-5/8 inches (41 mm)][1-3/4 inches (45 mm)][2 inches (51 mm)]<Insert dimension>.
2. Face Size and Shape: [9 inches (229 mm) square][12 inches (305 mm) square][18 inches (457 mm) square][As indicated]<Insert dimensions and shape>.
3. Color: [As indicated by manufacturer's designations][Match Architect's sample][As selected by Architect from manufacturer's full range]<Insert color>.

2.4 ASPHALT-BLOCK PAVERS

A. Asphalt-Block Pavers: Solid units made from asphalt cement complying with ASTM D312, Type III; inorganic stone dust or cement filler; and coarse aggregate, consisting of clean, hard, unweathered stone crushed into angular particles varying in size up to 3/8 inch (9.5 mm).

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Hanover Architectural Products**]
b. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Hanover Architectural Products**]
b. <**Insert manufacturer's name**>

3. Thickness: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**]<**Insert dimension**>.
4. Face Size: [**4 by 6 inches (102 by 152 mm)**][**6 by 6 inches (152 by 152 mm)**][**8 by 8 inches (203 by 203 mm)**][**5 by 12 inches (127 by 305 mm)**][**6 by 12 inches (152 by 305 mm)**][**8-inch-(203-mm-) wide hexagon**]<**Insert dimensions**>.
5. Dimensional Tolerances: Plus or minus **1/16 inch (1.6 mm)**.
6. Finish: [**Natural, smooth**][**Ground**][**Ground and sandblasted**].
7. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

2.5 STONE PAVERS

A. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.

B. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.

C. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Granite Pavers: Rectangular paving slabs made from granite complying with ASTM C615/C615M.

1. Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**medium**][**fine**] grain.
2. Finish: [**Honed**][**Thermal**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
3. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
4. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**] unless otherwise indicated.
5. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

G. Limestone Pavers: Rectangular paving slabs made from limestone complying with ASTM C568/C568M.

1. Classification: [**II Medium-Density**][**III High-Density**].
2. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to

ASTM C241/C241M or ASTM C1353.

3. Indiana Oolitic Limestone Grade and Color: [**Select, buff**][**Select, gray**][**Standard, buff**][**Standard, gray**][**Rustic, buff**][**Rustic, gray**][**Variegated**], according to grade and color classification established by ILI.
4. Finish: [**Smooth**][**Chat sawed**][**Shot sawed**][**As indicated**]<**Insert finish**>.
5. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
6. Thickness: Not less than [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.
7. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

H. Marble Pavers: Rectangular paving slabs made from marble complying with ASTM C503/C503M.

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Description: Uniform, fine- to medium-grained, [**white**]<**Insert color**> stone with only slight veining.
3. Finish: [**Honed**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
4. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
5. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**] unless otherwise indicated.
6. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

I. Quartz-Based Stone Pavers: [**Rectangular paving slabs**][**Random polygonal flagstones**] made from quartz-based stone complying with ASTM C616/C616M, Classification [**I Sandstone**][**II Quartzitic Sandstone**][**III Quartzite**].

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Finish: [**Sand rubbed**][**Natural cleft**][**Thermal**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
3. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
4. Thickness: Not less than [**1 inch (25 mm)**][**1-1/4 inches (32 mm)**][**1-1/2 inches (38 mm)**][**1-5/8 inches (40 mm)**][**2 inches (50 mm)**] unless otherwise indicated.
5. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**][**Random**]<**Insert dimensions**>.

J. Slate Pavers: [**Rectangular paving slabs**][**Random polygonal flagstones**] made from slate complying with ASTM C629/C629M, Classification I Exterior, with a fine, even grain[**and unfading color,**] from clear, sound stock.

1. Color: [**Black**][**Blue-black**][**Gray**][**Blue-gray**][**Green**][**Purple**][**Mottled purple and green**][**Red**].
2. Stone Abrasion Resistance: Minimum value of [**8**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
3. Finish: [**Honed**][**Sand rubbed**][**Natural cleft**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
4. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
5. Thickness: Not less than [**1/2 inch (13 mm)**][**3/4 inch (20 mm)**][**1 inch (25 mm)**] unless otherwise indicated.
6. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm)**

square][**9 by 18 inches (229 by 457 mm)**][**As indicated**][**Random**]<**Insert dimensions**>.

K. Travertine Pavers: Rectangular paving slabs made from travertine complying with ASTM C1527/C1527M, Classification I Exterior.

1. Stone Abrasion Resistance: Minimum value of [**10**]<**Insert value**>, based on testing according to ASTM C241/C241M or ASTM C1353.
2. Cut: Vein cut.
3. Filling: Fill pores on faces of stone with cementitious filler of color [**selected by Architect**][**matching Architect's sample**].
4. Finish: [**Honed**][**As indicated**][**Match Architect's sample**]<**Insert finish**>.
5. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
6. Thickness: Not less than [**3/4 inch (20 mm)**][**30 mm**][**1-1/4 inches (32 mm)**] unless otherwise indicated.
7. Face Size: [**9 inches (229 mm) square**][**12 inches (305 mm) square**][**18 inches (457 mm) square**][**9 by 18 inches (229 by 457 mm)**][**As indicated**]<**Insert dimensions**>.

L. Rough Granite Pavers: Rectangular[**tumbled**] paving stones, with split[**or thermal-finished**] faces and edges, made from granite complying with ASTM C615/C615M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Buechel Stone Corp**]
    b. [**Cold Spring Granite Company**]
    c. [**Fletcher Granite Company**]
    d. [**Granicor**]
    e. [**Milestone Imports, Inc.**]
    f. [**North Carolina Granite Corporation**]
    g. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Buechel Stone Corp**]
    b. [**Cold Spring Granite Company**]
    c. [**Fletcher Granite Company**]
    d. [**Granicor**]
    e. [**Milestone Imports, Inc.**]
    f. [**North Carolina Granite Corporation**]
    g. <**Insert manufacturer's name**>

3. Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**medium**][**fine**] grain.
4. Thickness: [**1-1/4 inches (32 mm)**][**2 inches (51 mm)**][**3 inches (76 mm)**][**4 inches (102 mm)**][**4 inches (102 mm), plus or minus 1/2 inch (13 mm)**]<**Insert dimension**>.
5. Face Size: [**4 by 4 inches (100 by 100 mm), plus or minus 1/2 inch (13 mm)**][**3 to 5 inches (75 to 125 mm) by 8 to 12 inches (200 to 300 mm)**][**As indicated**]<**Insert dimensions**>.

2.6 CURBS AND EDGE RESTRAINTS

A. Plastic Edge Restraints: Manufacturer's standard triangular PVC extrusions [**1-3/4 inches (45 mm) high by 3-1/2 inches (89 mm) wide**][**3-1/8 inches (79 mm) high by 9-1/2 inches (241 mm) wide**] designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges; with pipe connectors and **3/8-inch (9.5-mm)** diameter by **12-inch- (300-mm-)** long steel spikes.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Brickstop Corporation**]
    b. [**Dimex LLC**]
    c. [**Oly-Ola Edgings, Inc.**]
    d. [**Pave Tech; Probst, Inc.**]
    e. [**Sure-loc Edging Corporation.**]
    f. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Brickstop Corporation**]
    b. [**Dimex LLC**]
    c. [**Oly-Ola Edgings, Inc.**]
    d. [**Pave Tech; Probst, Inc.**]
    e. [**Sure-loc Edging Corporation.**]
    f. <**Insert manufacturer's name**>

B. Steel Edge Restraints: Manufacturer's standard painted steel edging [**3/16 inch (4.8 mm) thick by 4 inches (100 mm) high**][**1/4 inch (6.4 mm) thick by 5 inches (125 mm) high**] with loops pressed from or welded to face to receive stakes at **36 inches (900 mm)** o.c. and steel stakes **15 inches (380 mm)** long for each loop.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Border Concepts, Inc**]
    b. [**COLMET**]
    c. [**J. D. Russell Company (The)**]
    d. [**Sure-loc Edging Corporation.**]
    e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Border Concepts, Inc**]
    b. [**COLMET**]
    c. [**J. D. Russell Company (The)**]
    d. [**Sure-loc Edging Corporation.**]
    e. <**Insert manufacturer's name**>

3. Color: [**As indicated by manufacturer's designations**][**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

C. Aluminum Edge Restraints: Manufacturer's standard [**straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high**][**straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high**][**L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high**][**L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high**] extruded-aluminum edging with loops pressed from face to receive stakes at **12 inches (300 mm)** o.c. and aluminum stakes **12 inches (300 mm)** long for each loop.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**Brickstop Corporation**]
   b. [**Curv-Rite, Inc**]
   c. [**Permaloc Corporation**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**Brickstop Corporation**]
   b. [**Curv-Rite, Inc**]
   c. [**Permaloc Corporation**]
   d. [**Sure-loc Edging Corporation.**]
   e. <**Insert manufacturer's name**>

D. Job-Built Concrete Edge Restraints: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of **3000 psi (20 MPa)**.

E. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than [**5000 psi (34 MPa)**][**6000 psi (41 MPa)**]<**Insert value**> and water absorption not more than 5 percent, in shapes and sizes indicated.

1. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
2. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site.
3. Regional Materials: Concrete curbs shall be manufactured within **100 miles (160 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
4. Indigenous Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
5. Regional Materials: Concrete curbs shall be manufactured within **500 miles (800 km)** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

6. Color and Texture: [**Match Architect's sample**][**As selected by Architect from manufacturer's full range**]<**Insert color and texture**>.

F. Granite Curbs: Granite curbing, with face battered **1 inch per foot (1:12)**, produced in random lengths not less than **36 inches (900 mm)** from granite complying with ASTM C615/C615M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**Cold Spring Granite Company**]
    b. [**Fletcher Granite Company**]
    c. [**Granicor**]
    d. [**New England Stone, Inc.**]
    e. [**North Carolina Granite Corporation**]
    f. [**Polycor Inc.**]
    g. [**Swenson Granite Works; a Polycor Inc. company**]
    h. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

    a. [**Cold Spring Granite Company**]
    b. [**Fletcher Granite Company**]
    c. [**Granicor**]
    d. [**New England Stone, Inc.**]
    e. [**North Carolina Granite Corporation**]
    f. [**Polycor Inc.**]
    g. [**Swenson Granite Works; a Polycor Inc. company**]
    h. <**Insert manufacturer's name**>

3. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site.
4. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site.
5. Regional Materials: Stone shall be fabricated within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.
6. Indigenous Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
7. Regional Materials: Stone shall be fabricated within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
8. Granite Color and Grain: [**Light gray**][**Dark gray**][**Buff**][**White**][**Black**][**Pink**]<**Insert color**> with [**fine**][**medium**][**coarse**] grain.
9. Top Width: [**4 inches (102 mm)**][**5 inches (127 mm)**][**6 inches (152 mm)**]<**Insert dimension**>.
10. Face Height: [**4 inches (102 mm)**][**6 inches (152 mm)**][**8 inches (203 mm)**]<**Insert dimension**>.
11. Total Height: [**12 inches (305 mm)**][**16 inches (406 mm)**][**18 inches (457 mm)**]<**Insert dimension**>.
12. Top Finish: [**Sawed**][**Thermal**][**Bush hammered**].

13. Face Finish: [**Split**][**Sawed**][**Thermal**][**Bush hammered**].

G. <**Insert requirements**>.

2.7 ACCESSORIES

A. Cork Joint Filler: Preformed strips complying with ASTM D1752, Type II.

B. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.8 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with [**ASTM D448 for Size No. 57**][**ASTM D2940/D2940M, subbase material**][**requirements in Section 312000 "Earth Moving" for subbase material**].

B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with [**ASTM D448 for Size No. 8**][**ASTM D2940/D2940M, base material**][**requirements in Section 312000 "Earth Moving" for base course**].

C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.

D. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D448 for Size No. 10.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing **No. 16 (1.18-mm)** sieve and no more than 10 percent passing **No. 200 (0.075-mm)** sieve.

1. Provide sand of color needed to produce required joint color.

F. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: **No. 60 (0.250-mm)** sieve, maximum; ASTM D4751.
3. Permittivity: 0.02 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

G. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: **No. 40 (0.425-mm)** sieve, maximum; ASTM D4751.
3. Permittivity: 0.5 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

H. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.9 BITUMINOUS SETTING-BED MATERIALS

A. Primer for Base: ASTM D2028/D2028M, cutback asphalt, grade as recommended by unit paver manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D1073, No. 2 or No. 3.

C. Asphalt Cement: ASTM D3381/D3381M, Viscosity Grade AC-10 or Grade AC-20.

D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing **No. 16 (1.18-mm)** sieve and no more than 10 percent passing **No. 200 (0.075-mm)** sieve.

1. Provide sand of color needed to produce required joint color.

2.10 MORTAR SETTING-BED MATERIALS

A. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Portland Cement: ASTM C150/C150M, Type I or Type II.

G. Hydrated Lime: ASTM C207, Type S.

H. Sand: ASTM C144.

I. Latex Additive: [**Manufacturer's standard**][**acrylic resin**][**or**][**styrene-butadiene-rubber**] water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

J. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Jamo Inc**]
   h. [**Laticrete International, Inc.**]
   i. [**MAPEI Corporation**]
   j. [**Parex, a Sika brand**]
   k. [**ProSpec; H.B. Fuller Construction Products Inc.**]
   l. [**Sakrete; CRH Americas, Oldcastle APG**]
   m. [**Southern Grouts & Mortars, Inc**]
   n. [**Summitville Tiles, Inc.**]
   o. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. [**ARDEX Americas**]
   b. [**Boiardi Products Corporation; a QEP company**]
   c. [**Bostik; Arkema**]
   d. [**C-Cure**]
   e. [**Custom Building Products**]
   f. [**H.B. Fuller Construction Products Inc. / TEC**]
   g. [**Jamo Inc**]
   h. [**Laticrete International, Inc.**]
   i. [**MAPEI Corporation**]
   j. [**Parex, a Sika brand**]
   k. [**ProSpec; H.B. Fuller Construction Products Inc.**]
   l. [**Sakrete; CRH Americas, Oldcastle APG**]
   m. [**Southern Grouts & Mortars, Inc**]
   n. [**Summitville Tiles, Inc.**]
   o. <**Insert manufacturer's name**>

3. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
4. Provide prepackaged, dry-mortar mix combined with [**acrylic resin**][**or**][**styrene-butadiene-rubber**] liquid-latex additive at Project site.
5. Provide product that is approved by manufacturer for application thickness of [**5/8 inch (16 mm)**]<**Insert value**>.

K. Water: Potable.

L. Reinforcing Wire Fabric: Galvanized, welded wire fabric, **2 by 2 inches (50.8 by 50.8 mm)** by **0.062 inch (1.57 mm)** in diameter; comply with ASTM A1064/A1064M except for minimum wire size.

2.11 GROUT MATERIALS

A. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

B. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site.

C. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

D. Indigenous Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. Regional Materials: Aggregate for mortar and grout[**, cement, and lime**] shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Sand-Portland Cement Grout: ANSI A108.10, made of white or gray cement and white or colored aggregate as required to produce color indicated.

1. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved, through testing and experience, to be satisfactory for use in portland cement grout.

a. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1) [**Davis Colors**]
2) [**Lanxess Corporation**]
3) [**Solomon Colors Inc.**]
4) <**Insert manufacturer's name**>

b. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

1) [**Davis Colors**]
2) [**Lanxess Corporation**]
3) [**Solomon Colors Inc.**]
4) <**Insert manufacturer's name**>

G. Standard Cement Grout: ANSI A118.6, sanded.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering**

products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
k. [**Sakrete; CRH Americas, Oldcastle APG**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]
n. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**Boiardi Products Corporation; a QEP company**]
b. [**Bostik; Arkema**]
c. [**C-Cure**]
d. [**Custom Building Products**]
e. [**H.B. Fuller Construction Products Inc. / TEC**]
f. [**Jamo Inc**]
g. [**Laticrete International, Inc.**]
h. [**MAPEI Corporation**]
i. [**Parex, a Sika brand**]
j. [**ProSpec; H.B. Fuller Construction Products Inc.**]
k. [**Sakrete; CRH Americas, Oldcastle APG**]
l. [**Southern Grouts & Mortars, Inc**]
m. [**Summitville Tiles, Inc.**]
n. <**Insert manufacturer's name**>

H. High-Performance Cement Grout: ANSI A118.7, sanded.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Jamo Inc**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]

m. <**Insert manufacturer's name**>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

a. [**ARDEX Americas**]
b. [**Boiardi Products Corporation; a QEP company**]
c. [**Bostik; Arkema**]
d. [**C-Cure**]
e. [**Custom Building Products**]
f. [**H.B. Fuller Construction Products Inc. / TEC**]
g. [**Jamo Inc**]
h. [**Laticrete International, Inc.**]
i. [**MAPEI Corporation**]
j. [**Sakrete; CRH Americas, Oldcastle APG**]
k. [**Southern Grouts & Mortars, Inc**]
l. [**Summitville Tiles, Inc.**]
m. <**Insert manufacturer's name**>

3. Polymer Type:

a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
b. [**Acrylic resin**][**or**][**styrene-butadiene rubber**] in liquid-latex form for addition to prepackaged dry-grout mix.

I. Grout Colors: [**As indicated by manufacturer's designations**][**Match Architect's samples**][**As selected by Architect from manufacturer's full range**]<**Insert color**>.

J. Water: Potable.

2.12 BITUMINOUS SETTING-BED MIX

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to **300 deg F (149 deg C)**.

2.13 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Mortar-Bed Bond Coat: Mix neat cement and [**latex additive**][**water**] to a creamy consistency.

C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C270, Proportion Specification.

D. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

E. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.

F. Thinset Mortar Bond Coat: Proportion and mix according to manufacturer's written instructions.

G. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.

1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.
2. Colored-Aggregate Grout: Produce color required by combining colored aggregates with portland cement of selected color.

H. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected[**and waterproofing protection is in place**].

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive [**subbase**][**and**][**base**] course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where

possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: [**Running bond**][**Herringbone**][**Basket weave**][**Grid**][**As indicated**][**Match and continue existing unit paver joint pattern**].

F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

1. Provide joint filler at waterproofing that is turned up on vertical surfaces[**unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete**].

G. Tolerances:

1. Do not exceed **1/32-inch (0.8-mm)** unit-to-unit offset from flush (lippage) or **1/8 inch in 10 feet (3 mm in 3 m)** from level, or indicated slope, for finished surface of paving.
2. Do not exceed[**1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and**] **1/4 inch in 10 feet (6 mm in 3 m)** from level, or indicated slope, for finished surface of paving.

H. Expansion and Control Joints:

1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints[**unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete**]. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."
2. Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

I. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least **1 inch (25 mm)** below top edge.
3. Install job-built concrete edge restraints to comply with requirements in Section 033000 "Cast-in-Place Concrete."
4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

J. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.

1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.4 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least [**95**]<**Insert number**> percent of [**ASTM D698**][**ASTM D1557**] laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least **12 inches (300 mm)**.

D. Place aggregate[**subbase and**] base, compact by tamping with plate vibrator, and screed to depth indicated.

E. Place aggregate[**subbase and**] base, compact to 100 percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.

F. Place drainage geotextile over compacted base course, overlapping ends and edges at least **12 inches (300 mm)**.

G. Place leveling course and screed to a thickness of **1 to 1-1/2 inches (25 to 38 mm)**, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

H. Treat leveling course with herbicide to inhibit growth of grass and weeds.

I. Set pavers with a minimum joint width of **1/16 inch (1.5 mm)** and a maximum of **1/8 inch (3 mm)**, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed [**3/8 inch (10 mm)**]<**Insert dimension**> with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a **3500- to 5000-lbf (16- to 22-kN)** compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least **36 inches (900 mm)** of uncompacted pavers adjacent to temporary edges.
2. Before ending each day's work, compact installed concrete pavers except for **36-inch (900-mm)** width of uncompacted pavers adjacent to temporary edges (laying faces).
3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within **36 inches (90 mm)** of laying face.
4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

L. Do not allow traffic on installed pavers until sand has been vibrated into joints.

M. Repeat joint-filling process 30 days later.

3.5 BITUMINOUS SETTING-BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating **3/4-inch- (19-mm-)** deep control bars approximately **11 feet (3.3 m)** apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of **250 deg F (121 deg C)**. Strike setting bed smooth, firm, even, and not less than **3/4 inch (19 mm)** thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of **3/4 inch (19 mm)**. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to **185 deg F (85 deg C)**.

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of **1/16 inch (1.6 mm)**. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.6 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed **1/16-inch (1.6-mm)** thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately **1/2 inch (13 mm)**.

E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

G. Wet brick pavers before laying if the initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

H. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform **1/16-inch- (1.5-mm-)** thick bond coat to mortar bed or to back of each paver with a flat trowel.

I. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

J. Spaced Joint Widths: Provide [**3/8-inch (10-mm)**][**1/2-inch (13-mm)**][**3/4-inch (19-mm)**] nominal joint width with variations not exceeding plus or minus [**1/16 inch (1.5 mm)**][**1/8 inch (3 mm)**][**3/16 inch (4.5 mm)**].

K. Grouted Joints: Grout paver joints complying with ANSI A108.10.

L. Grout joints as soon as possible after initial set of setting bed.

1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.

M. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.7 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 31 25 14 23

Task	Specification(s)
01 00 00 00	01 00 00 00
01 10 00 00	01 00 00 00
01 11 00 00	01 00 00 00
01 11 13 00	01 11 13 00, 01 00 00 00
01 20 00 00	01 00 00 00
01 22 00 00	01 22 00 00, 01 00 00 00
01 22 16 00	01 00 00 00, 01 22 00 00
01 22 20 00	01 00 00 00, 01 22 00 00
01 22 23 00	01 00 00 00, 01 22 00 00
01 30 00 00	01 00 00 00
01 35 00 00	01 00 00 00
01 35 29 00	01 00 00 00
01 35 33 00	01 00 00 00
01 40 00 00	01 40 00 00, 01 00 00 00
01 41 00 00	01 00 00 00, 01 40 00 00
01 41 26 00	01 00 00 00, 01 40 00 00
01 42 00 00	01 42 00 00, 01 00 00 00, 01 40 00 00
01 42 13 00	01 00 00 00, 01 40 00 00, 01 42 00 00
01 42 16 00	01 00 00 00, 01 40 00 00, 01 42 00 00
01 42 19 00	01 00 00 00, 01 40 00 00, 01 42 00 00
01 42 21 00	01 00 00 00, 01 40 00 00, 01 42 00 00
01 45 00 00	01 00 00 00, 01 40 00 00
01 45 23 00	01 00 00 00, 01 22 00 00, 01 40 00 00
01 45 29 00	01 00 00 00, 01 22 00 00, 01 40 00 00
01 50 00 00	01 50 00 00, 01 00 00 00
01 51 00 00	01 00 00 00
01 51 13 00	01 51 13 00, 01 00 00 00, 26 24 16 00
01 51 26 00	01 00 00 00
01 52 00 00	01 00 00 00
01 52 13 00	01 00 00 00, 01 22 00 00, 01 50 00 00
01 52 19 00	01 00 00 00, 01 50 00 00
01 53 00 00	01 00 00 00
01 53 16 00	01 00 00 00, 01 22 00 00
01 53 23 00	01 00 00 00
01 54 00 00	01 00 00 00
01 54 23 00	01 54 23 00, 01 54 23 00a, 01 00 00 00, 01 22 00 00
01 54 26 00	01 00 00 00, 01 22 00 00
01 55 00 00	01 00 00 00
01 55 23 00	01 00 00 00, 01 22 00 00
01 55 26 00	01 55 26 00, 01 55 26 00a, 01 00 00 00, 01 22 00 00
01 56 00 00	01 00 00 00
01 56 16 00	01 00 00 00, 01 22 00 00
01 56 26 00	01 56 26 00, 01 00 00 00, 01 22 00 00
01 56 29 00	01 00 00 00, 01 22 00 00
01 56 33 00	01 00 00 00, 01 22 00 00
01 56 39 00	01 56 39 00, 01 00 00 00, 01 22 00 00
01 57 00 00	01 00 00 00
01 57 23 00	01 57 23 00, 01 00 00 00
01 57 26 00	01 00 00 00
01 58 00 00	01 00 00 00
01 58 13 00	01 58 13 00, 01 58 13 00a, 01 00 00 00, 01 22 00 00
01 60 00 00	01 60 00 00, 01 00 00 00
01 66 00 00	01 00 00 00, 01 60 00 00
01 66 19 00	01 00 00 00, 01 22 00 00, 01 60 00 00

Task	Specification(s)
01 70 00 00	01 00 00 00
01 71 00 00	01 00 00 00
01 71 13 00	01 00 00 00, 01 22 00 00
01 71 23 00	01 00 00 00
01 71 23 16	01 00 00 00
01 71 36 00	01 00 00 00
01 74 00 00	01 00 00 00
01 74 13 00	01 00 00 00
01 74 16 00	01 00 00 00, 01 22 00 00
01 74 19 00	01 74 19 00, 01 00 00 00, 01 22 00 00
01 74 23 00	01 00 00 00
01 91 13 00	01 91 13 00
01 00 00 00MOD000	01 00 00 00, 26 01 00 00
02 41 13 13	02 41 19 00
02 41 19 00	02 41 19 00
02 41 19 13	02 41 19 13, 02 41 19 00
02 61 00 00	02 61 00 00
02 61 26 00	02 61 00 00, 02 82 33 00
02 82 16 00	02 82 16 00
02 82 33 00	02 82 33 00, 02 82 33 00a, 01 22 00 00, 02 82 16 00, 02 83 19 00
02 83 00 00	02 83 00 00
02 83 19 00	02 83 19 00, 02 83 19 00a, 02 83 19 00b, 02 83 00 00
02 83 19 13	02 83 00 00, 02 83 19 00, 02 83 19 00a, 02 83 19 00b
02 83 33 00	02 83 00 00
02 83 33 13	02 83 00 00, 02 83 19 00, 02 83 19 00a, 02 83 19 00b
02 84 16 00	02 84 16 00
02 87 13 00	02 87 13 00
02 87 13 33	02 87 13 00
02 87 16 13	02 87 16 13
02 89 00 00	01 22 00 00, 02 83 00 00, 02 83 19 00, 02 83 19 00a, 02 83 19 00b
02 90 55 00	01 22 00 00
05 01 70 51	05 01 70 51
05 01 70 61	05 01 70 61
05 01 70 63	05 01 70 63
05 05 19 00	05 05 19 00
05 05 21 00	05 12 00 00
05 05 23 00	01 22 00 00, 05 12 00 00, 05 05 19 00
05 12 00 00	05 12 00 00
05 12 23 00	05 12 00 00, 05 40 00 00, 05 05 19 00
05 13 00 00	05 12 00 00, 05 05 19 00
05 14 13 00	01 22 00 00
05 15 16 00	05 05 19 00, 05 70 00 00
05 15 19 00	05 70 00 00
05 21 00 00	05 21 00 00
05 21 19 00	05 21 00 00
05 31 13 00	05 31 13 00
05 31 33 00	05 31 13 00
05 36 00 00	05 31 13 00
05 40 00 00	05 40 00 00
05 41 00 00	05 40 00 00
05 42 00 00	05 40 00 00
05 42 13 00	05 40 00 00
05 42 23 00	05 40 00 00

Task	Specification(s)
05 43 00 00	01 22 00 00, 05 40 00 00, 05 05 19 00
05 45 00 00	05 40 00 00
05 45 16 00	05 40 00 00
05 70 00 00	05 70 00 00
05 71 00 00	05 71 00 00, 05 70 00 00
05 71 13 00	05 71 13 00, 05 70 00 00, 05 71 00 00
05 73 00 00	05 73 00 00, 05 73 00 00a, 05 70 00 00, 05 75 00 00
05 73 23 00	05 70 00 00, 05 73 00 00, 05 73 00 00a, 05 75 00 00
05 75 00 00	05 75 00 00, 05 70 00 00
06 05 23 00	06 10 00 00, 06 13 00 00
06 05 73 13	01 22 00 00
06 05 73 33	06 10 00 00, 06 13 00 00
06 10 00 00	06 10 00 00
06 11 13 00	06 10 00 00
06 11 16 00	01 22 00 00, 06 10 00 00
06 13 00 00	06 13 00 00
06 13 23 00	06 13 00 00
06 15 00 00	06 15 00 00, 06 15 00 00a
06 15 13 00	06 10 00 00, 06 15 00 00, 06 15 00 00a
06 16 00 00	06 16 00 00
06 16 23 00	06 10 00 00, 06 16 00 00
06 16 33 00	06 10 00 00, 06 16 00 00
06 16 43 00	06 10 00 00, 06 16 00 00
07 62 00 00	07 62 00 00
07 62 13 00	07 62 00 00
07 62 19 00	07 62 00 00
07 63 00 00	07 63 00 00, 07 63 00 00a, 07 63 00 00b, 07 62 00 00
07 65 16 00	07 65 16 00, 07 65 16 00a, 07 65 16 00b
07 91 00 00	07 91 00 00
07 91 23 00	07 91 00 00, 07 92 00 00
07 91 26 00	07 91 00 00, 07 92 00 00
07 91 33 00	07 91 00 00
07 92 00 00	07 92 00 00
07 92 13 00	07 92 00 00
07 92 19 00	07 92 19 00, 07 92 00 00
07 95 13 00	07 95 13 00
07 95 13 13	07 95 13 13, 07 95 13 00
07 95 13 16	07 95 13 16, 07 95 13 13, 07 95 13 00
09 01 20 00	09 01 20 00
09 01 20 91	09 01 20 91, 09 01 20 00
09 01 30 91	09 01 30 91
09 01 60 91	09 01 60 91, 09 01 60 91a, 09 01 60 91b, 09 01 60 91c, 01 22 00 00, 07 92 00 00
09 01 90 52	09 01 90 52, 09 01 90 52a
09 05 61 13	09 05 61 13
09 05 71 00	09 01 30 91
09 22 13 13	09 23 00 00
09 22 13 23	09 23 00 00
09 22 16 00	09 22 16 00
09 22 16 13	09 22 16 00
09 22 36 13	09 23 00 00
09 22 36 23	09 23 00 00
09 22 36 33	09 23 00 00
09 23 00 00	09 23 00 00
09 23 13 00	09 23 00 00

Task	Specification(s)
09 24 00 00	09 24 00 00
09 24 13 00	09 23 00 00, 09 24 00 00
09 24 23 00	09 24 00 00
09 24 33 00	09 24 00 00
09 28 13 00	09 29 00 00, 09 01 30 91
09 29 00 00	09 29 00 00
09 29 10 00	01 22 00 00, 09 29 00 00
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09 51 13 00	09 51 13 00
09 51 23 00	09 51 23 00
09 51 33 00	09 51 33 00
09 51 33 13	09 51 33 00
09 51 33 23	09 51 33 00
09 51 33 33	09 51 33 00
09 53 23 00	09 51 13 00
09 54 00 00	09 54 00 00, 09 54 00 00a
09 54 16 00	09 54 00 00, 09 54 00 00a
09 54 23 00	09 54 23 00, 09 51 33 00, 09 54 00 00, 09 54 00 00a
09 84 13 00	09 29 00 00
09 91 13 00	09 91 13 00, 01 22 00 00, 09 93 00 00
09 91 23 00	09 91 23 00, 09 91 13 00
09 91 33 00	09 93 00 00
09 93 00 00	09 93 00 00
09 93 13 00	09 93 00 00
09 93 13 53	09 93 00 00
09 93 23 00	09 93 00 00
09 93 23 13	09 93 00 00
09 93 23 53	09 93 00 00
09 96 00 00	09 96 00 00
09 96 53 00	09 96 53 00, 09 91 13 00
09 96 56 00	09 96 00 00
09 96 66 00	09 97 26 00
09 97 13 23	09 96 00 00
09 97 13 24	09 96 00 00
09 97 26 00	09 97 26 00
09 97 26 13	09 96 00 00, 09 97 26 00
09 97 35 00	09 91 23 00
09 97 63 00	09 97 63 00, 01 22 00 00, 09 96 00 00
13 46 13 00	13 46 13 00
26 01 00 00	26 01 00 00
26 01 10 00	26 01 00 00
26 01 10 91	26 01 00 00
26 01 20 00	26 01 00 00
26 01 20 91	26 01 00 00
26 01 50 00	26 01 00 00
26 01 50 51	02 84 16 00, 26 01 00 00
26 01 50 52	02 84 16 00, 26 01 00 00
26 01 50 53	02 84 16 00, 26 01 00 00
26 01 50 81	26 01 00 00
26 05 00 00	26 05 00 00
26 05 13 00	26 05 13 00, 26 05 00 00
26 05 13 16	26 05 13 00, 26 05 19 00, 26 05 00 00
26 05 19 00	26 05 19 00, 26 05 00 00

Task	Specification(s)
26 05 19 13	26 05 19 00, 26 05 39 00, 26 05 00 00
26 05 19 16	26 05 13 00, 26 05 19 00, 26 05 23 00, 26 05 00 00, 27 11 00 00, 27 13 13 00, 27 15 33 00
26 05 23 00	26 05 23 00, 26 05 00 00
26 05 26 00	26 05 26 00, 26 05 00 00
26 05 29 00	26 05 29 00, 05 40 00 00, 05 05 19 00, 26 05 00 00
26 05 33 00	26 05 00 00
26 05 33 13	26 05 33 13, 26 05 19 00, 26 05 00 00, 27 11 00 00, 27 13 13 00, 27 15 33 00
26 05 33 16	26 05 33 16, 26 05 00 00, 26 27 26 00
26 05 33 23	26 05 33 23, 26 05 39 00, 26 05 00 00
26 05 36 00	26 05 36 00, 26 05 00 00
26 05 39 00	26 05 39 00, 26 05 00 00
26 05 43 00	26 05 43 00, 26 05 43 00a, 26 05 19 00, 26 05 00 00, 27 11 00 00, 27 13 13 00, 27 15 33 00
26 05 46 00	26 05 46 00, 01 55 26 00a, 26 05 00 00
26 05 53 00	26 05 53 00, 26 05 00 00
26 05 83 00	26 05 13 00, 26 05 19 00, 26 05 00 00
26 08 00 00	26 08 00 00
26 09 00 00	26 09 00 00, 26 09 00 00a
26 09 13 00	26 09 00 00, 26 09 00 00a
26 09 23 00	26 09 23 00, 26 09 23 00a, 02 84 16 00, 26 09 00 00, 26 09 00 00a, 26 24 19 00
26 11 16 00	26 11 16 00, 26 11 16 00a
26 11 16 11	26 11 16 11, 26 11 16 00, 26 11 16 00a
26 12 13 00	26 12 13 00, 26 22 13 00
26 12 16 00	26 12 16 00, 26 22 13 00
26 12 19 00	26 12 19 00, 26 12 19 00a, 26 12 13 00, 26 22 13 00
26 13 29 00	26 13 29 00, 26 11 16 11
26 18 36 00	26 11 16 11
26 19 18 00	26 05 00 00
26 19 80 60	26 05 00 00
26 21 13 00	26 05 13 00, 26 05 19 00
26 21 16 00	26 21 16 00, 26 05 13 00, 26 05 19 00
26 22 00 00	26 12 19 00a
26 22 13 00	26 22 13 00, 26 12 19 00a
26 24 13 00	26 24 13 00, 26 27 13 00, 26 28 16 00
26 24 16 00	26 24 16 00, 26 24 16 00a
26 24 19 00	26 24 19 00, 26 09 23 00, 26 11 16 11, 26 27 33 00
26 25 00 00	26 25 00 00
26 25 13 00	26 25 00 00
26 25 16 00	26 25 00 00
26 27 13 00	26 27 13 00
26 27 16 00	26 27 16 00, 26 09 23 00, 26 24 19 00
26 27 19 00	26 27 19 00, 26 05 39 00
26 27 23 00	26 27 26 00
26 27 26 00	26 27 26 00, 26 27 26 00a, 26 27 26 00b, 26 09 23 00
26 27 33 00	26 27 33 00
26 27 73 00	26 27 26 00
26 28 13 00	26 28 13 00, 26 11 16 11
26 28 16 00	26 28 16 00
26 28 16 13	26 24 16 00, 26 28 16 00
26 28 16 16	26 28 16 00
26 29 13 00	26 29 13 00, 26 29 13 00a
26 29 13 13	26 29 13 00, 26 29 13 00a
26 29 23 00	26 29 23 00
26 29 33 13	26 29 33 13, 26 29 33 13a

Task	Specification(s)
26 31 00 00	26 31 00 00, 26 01 00 00
26 32 13 00	26 32 13 19
26 32 13 13	26 32 13 13, 26 32 13 19
26 32 13 19	26 32 13 19
26 33 43 00	26 33 43 00, 26 33 43 00a, 27 52 23 00
26 33 53 00	26 33 53 00
26 35 33 00	26 35 33 00
26 35 33 16	26 09 23 00, 26 35 33 00
26 36 00 00	26 36 00 00
26 36 13 00	26 28 16 00, 26 36 00 00
26 36 23 00	26 28 16 00, 26 36 00 00
26 43 13 00	26 43 13 00
26 50 00 00	26 50 00 00
26 51 00 00	26 50 00 00
26 51 13 00	26 50 00 00
26 51 16 00	26 50 00 00
26 51 19 00	26 01 00 00, 26 50 00 00
26 51 23 00	26 50 00 00
26 51 33 00	02 84 16 00, 26 50 00 00
26 52 00 00	26 50 00 00
26 52 13 00	26 50 00 00
26 52 13 13	26 50 00 00
26 52 13 16	26 50 00 00
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26 54 19 00	26 50 00 00
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26 55 29 00	26 50 00 00
26 55 53 00	26 50 00 00
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26 55 53 12	26 50 00 00
26 55 53 13	26 50 00 00
26 55 61 00	26 55 61 00, 26 50 00 00
26 55 68 00	26 55 68 00, 26 50 00 00
26 56 00 00	26 50 00 00
26 56 13 00	02 41 19 00, 26 50 00 00
26 56 18 00	26 50 00 00
26 56 19 00	26 50 00 00
26 56 21 00	26 50 00 00
26 00 00 00MOD000	26 01 00 00
27 11 00 00	27 11 00 00
27 11 16 00	27 11 00 00
27 11 19 00	27 11 00 00, 27 13 23 00
27 11 23 00	27 11 00 00
27 13 13 00	27 13 13 00
27 13 13 13	26 05 13 00, 26 05 19 00, 27 13 13 00
27 13 23 00	27 13 23 00
27 13 23 13	27 13 23 00
27 15 13 00	27 15 13 00, 26 05 13 00, 26 05 19 00, 26 05 23 00
27 15 23 00	27 15 23 00
27 15 33 00	27 15 33 00, 26 05 13 00, 26 05 19 00, 26 05 23 00
27 15 53 00	27 13 23 00

Task	Specification(s)
27 16 16 00	27 13 23 00
27 16 19 00	26 05 19 00, 27 13 23 00
27 21 16 00	27 13 23 00
27 32 13 00	26 27 26 00
27 41 23 00	27 41 23 00, 26 33 43 00a
27 41 33 00	27 41 33 00
27 51 23 20	27 51 23 20
27 51 43 00	26 33 43 00a, 27 41 23 00
27 52 23 00	27 52 23 00
27 53 13 00	27 53 13 00
27 53 13 13	27 53 13 00
27 53 13 16	27 53 13 00
28 00 00 00	28 10 00 00a
28 05 00 00	28 10 00 00a
28 05 26 00	28 10 00 00a
28 05 53 00	28 10 00 00a
28 10 00 00	28 10 00 00, 28 10 00 00a, 28 10 00 00b
28 15 00 00	28 15 00 00, 28 15 00 00a, 28 15 00 00b, 28 15 00 00c, 28 15 00 00d, 28 15 00 00e, 28 15 00 00f, 28 15 00 00g, 28 10 00 00, 28 10 00 00a, 28 10 00 00b
28 15 11 00	28 15 11 00, 28 10 00 00, 28 10 00 00a, 28 10 00 00b, 28 15 00 00, 28 15 00 00a, 28 15 00 00b, 28 15 00 00c, 28 15 00 00d, 28 15 00 00e, 28 15 00 00f, 28 15 00 00g
28 15 11 13	28 10 00 00, 28 10 00 00a, 28 10 00 00b, 28 15 00 00, 28 15 11 00, 28 15 00 00a, 28 15 00 00b, 28 15 00 00c, 28 15 00 00d, 28 15 00 00e, 28 15 00 00f, 28 15 00 00g
28 16 00 00	28 10 00 00, 28 10 00 00a, 28 10 00 00b
28 16 11 00	28 16 11 00, 28 16 11 00a, 26 33 43 00a, 27 41 23 00, 28 10 00 00, 28 10 00 00a, 28 10 00 00b
28 18 00 00	28 10 00 00, 28 10 00 00a, 28 10 00 00b
28 18 11 00	28 10 00 00, 28 10 00 00a, 28 10 00 00b
28 20 00 00	28 20 00 00, 28 10 00 00a
28 21 00 00	28 10 00 00a, 28 20 00 00
28 21 31 00	26 09 23 00, 28 10 00 00a, 28 20 00 00, 28 16 11 00
28 40 00 00	28 40 00 00, 28 10 00 00a
28 41 00 00	28 10 00 00a, 28 40 00 00
28 41 15 00	28 10 00 00a, 28 40 00 00
28 42 00 00	28 10 00 00a, 28 40 00 00
28 42 11 00	28 10 00 00a, 28 40 00 00
28 42 15 00	28 10 00 00a, 28 40 00 00
28 43 00 00	28 10 00 00a, 28 40 00 00
28 46 00 00	28 46 00 00, 28 10 00 00a, 28 40 00 00
28 46 13 00	28 10 00 00a, 28 46 00 00, 28 40 00 00
28 46 13 31	28 10 00 00a, 28 46 00 00, 28 40 00 00
28 46 31 00	28 10 00 00a, 28 46 00 00, 28 40 00 00
28 46 31 11	28 10 00 00a, 28 46 00 00, 28 40 00 00
28 46 41 00	28 10 00 00a, 28 46 00 00, 28 40 00 00
28 46 41 11	28 10 00 00a, 28 46 00 00, 28 40 00 00
28 46 41 31	28 10 00 00a, 28 46 00 00, 28 40 00 00
28 47 00 00	28 47 00 00, 28 10 00 00a, 28 40 00 00
28 47 15 00	28 10 00 00a, 28 47 00 00, 28 40 00 00
28 47 17 00	28 10 00 00a, 28 47 00 00, 28 40 00 00
28 47 17 17	28 10 00 00a, 28 47 00 00, 28 40 00 00
28 47 21 00	28 10 00 00a, 28 47 00 00, 28 40 00 00
28 47 21 21	28 10 00 00a, 28 47 00 00, 28 40 00 00
28 49 00 00	28 10 00 00a, 28 40 00 00
28 49 11 00	28 10 00 00a, 28 16 11 00, 28 16 11 00a, 28 40 00 00

Task	Specification(s)
28 49 17 00	28 10 00 00a, 28 40 00 00
28 00 00 00MOD000	28 10 00 00a
31 05 13 00	31 05 13 00, 31 20 00 00
31 05 16 00	31 20 00 00, 31 05 13 00
31 20 00 00	31 20 00 00
31 22 00 00	31 20 00 00
31 22 13 00	31 20 00 00
31 22 16 00	31 20 00 00
31 22 16 13	31 20 00 00
31 22 19 00	31 20 00 00
31 22 19 13	31 20 00 00
31 23 00 00	31 20 00 00
31 23 16 00	31 20 00 00
31 23 16 13	31 23 16 13, 31 20 00 00
31 23 16 16	31 23 16 16, 31 20 00 00
31 23 16 26	31 20 00 00
31 23 16 33	31 20 00 00
31 23 16 36	31 20 00 00, 31 23 16 13
31 23 16 46	31 23 16 13
31 23 19 00	31 23 19 00, 31 20 00 00
31 23 23 00	31 20 00 00
31 23 23 23	31 20 00 00
31 25 14 23	31 25 14 23

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